A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT

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I hereby declare that the thesis entitled "**A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT**" submitted towards partial fulfillment of the requirements for the award of **MCh in UROLOGY** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Sandeep Sharma**, Professor & Head, Department of Urology, **Dr. Harmandeep Singh Chahal**, Professor, Department of Urology. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my Parents

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-Dr Narwade Pankaj Chandrakant

LIST OF ABBREVIATIONS

ATP	-	Adenosine tri phosphate
B.fragilis	-	Bacteroides fragilis
CRP	-	C reactive protein
DJ stent	-	Double j stent
DM	-	Diabetes mellitus
E.coli	-	Escherichia coli
EPN	-	Emphysematous pyelonephritis
Hb	-	Haemoglobin
IVU	-	Intravenous urogram
K.pneumoniae	-	Klebsiella pneumoniae
NAD	-	Nicotinamide adenine dinucleotide
NCCT KUB	-	Non contrast Computerised Tomographic Scan kidney, ureter and bladder
PCD	-	Percutaneous drainage
PCN	-	Percutaneous nephrostomy
PCT	-	Procalcitonin
SD	-	Standard deviation
USG	-	Ultrasonogram
UTI	-	Urinary tract infection

ABSTRACT

Introduction: The term emphysematous pyelonephritis (EPN) was first used by Schultz and Klorfein and is applied when gas formation in or around the kidney. EPN presents a urologic emergency. The situation of standard treatment of nephrectomy of affected kidney for emphysematous pyelonephritis has improved in the last two decades with computed tomography (CT) scan based diagnosis and advances in multi-disciplinary intensive care of sepsis syndrome aiming at renal conservation by minimal invasive treatment options.

Aim of Study: 1.To study clinical profile of patients presenting with emphysematous pyelonephritis. 2. To evaluate minimal invasive treatment options and outcome in management of emphysematous pyelonephritis.

Materials & Methods: This was the prospective observational study conducted among the patients admitted to Department of Urology, Dayanand Medical College and Hospital, Ludhiana from Sept 2022 to Aug 2024. Information was collected through a pre- designed proforma for each patient chosen to be a part of the study with detailed history, clinical examination and complete investigational workup required for diagnosis of EPN was done and patients managed with minimally invasive treatment. Surgery was last resort. Role of minimally invasive treatment options studied in terms of resolution of EPN.

Results: Diabetes mellitus was present in 33 (94%) patients along with urinary tract obstruction in 9 (25.71%) patients. Fever was the most common presenting clinical feature while Escherichia coli were the most common causative organism. 80% patients were managed successfully by minimally invasive treatment option and seven patients (20%) underwent nephrectomy.

Conclusion: Renal salvage necessitates a multidisciplinary approach, starting with comprehensive medical management and followed by carefully chosen, stepwise minimally invasive treatment. This has been shown to enhance patient outcomes and decrease the traditional morbidity linked with nephrectomy.

Keywords: Diabetes mellitus, emphysematous pyelonephritis, minimally invasive treatment, E coli.

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INTRODUCTION

Emphysematous pyelonephritis (EPN) was first described by Kelly and MacCallum[1] in 1898 and initially considered rare entity. The term "emphysematous pyelonephritis" was coined by Schultz and Klorfein[2, 3] and is used when gas formation occurs only in or around the kidney. It has also been referred to by various terms such as renal emphysema, pneumonephritis emphysematosa, and pneumonephrogram, but Schultz and Klorfein's designation is preferred [4].

Emphysematous pyelonephritis (EPN) is a devastating necrotizing lesion of infected renal tissues, typically observed in diabetic patients or those with obstructive urinary tract infections and caused by gas-forming bacteria utilizing glucose as a substrate. This condition can lead to acute sepsis and carries a poor prognosis if not urgently addressed, constituting a urologic emergency[5]. Mortality rates associated with EPN range widely from 7% to 75%, underscoring its life-threatening potential [6, 7].

Despite its historical rarity; the increased use of ultrasonography and computed tomography in evaluating patients with features of sepsis or complicated UTIs has led to more frequent recognition of EPN (8). Huang et al[8]. argue that EPN is not rare and should be considered an important clinical entity.

Historically managed with nephrectomy or open surgical drainage alongside antibiotics, the treatment approach for EPN has evolved. Hudson et al. introduced fluoroscopic-guided percutaneous drainage as an alternative treatment modality[9]. Advances in image-guided drainage procedures, including percutaneous drainage (PCD) and endoscopic stenting, along with medical therapy such as intravenous antibiotics and glycaemic control, are now employed.as a standard of care modality.

EPN primarily affects diabetics, a population at increased risk due to the systemic effects of diabetes on kidney function. Bilateral involvement occurs in approximately 10% of cases, and it can affect

solitary kidneys, making renal conservation an increasingly preferred strategy in many cases [10].

AIMS AND OBJECTIVES

1. To study clinical profile of patients presenting with emphysematous pyelonephritis.
2. To evaluate minimal invasive treatment options and outcome in management of emphysematous pyelonephritis.

REVIEW OF LITERATURE

Definition:

Emphysematous pyelonephritis (EPN) is a severe necrotizing infection that affects the upper urinary tract, renal parenchyma and perirenal tissues with increasing grades of severity and gloomy prognosis. This condition leads to gas formation in the renal parenchyma, collecting system, or perinephric tissue.

Emphysematous pyelitis (gas in the renal pelvis) or emphysematous cystitis (gas within the bladder wall and lumen) may occur independently of associated EPN.[11] Some investigators referred the term emphysematous pyelonephritis as renal parenchymal infection, whereas most prefer to include both conditions of renal parenchyma and perinephric tissues under the same designation[6]. The definition that is accepted is the possible manifestations of gas-forming acute renal infections.[8] EPN was first reported in 1898 by Kelly and MacCallum[1] and was named by Schultz and Klorfein[2] more than 60 years later due to gas accumulation characteristics. EPN is a life threatening disease, with reported mortality rates ranging from 40% to 90%[12].

Sites[13]:

Gas-forming infections can develop anywhere in the upper or lower urinary tracts, as follows:

1. Gas in the renal parenchyma (emphysematous nephritis)
2. Gas in calyx and pelvis (emphysematous pyelitis)
3. Gas in ureter(emphysematous ureteritis)
4. Gas in urinary bladder (emphysematous cystitis).

Aetiology:

Emphysematous pyelonephritis is a condition primarily observed in diabetic patients; however, in non-diabetic individuals, it is typically associated with the obstruction of the renal-ureteral system (Gillies & Flocks, 1941). [8,11-13]

As stated by Gillies and Flocks in 1941, three factors that are essential for gas formation are:

1. Urinary tract obstruction
2. Uncontrolled diabetes mellitus[11]
3. Gas producing organisms[6]
4. Defective immune system[6,14]

Causative organisms:

EPN is caused by organisms that are normally found in the urinary and gastrointestinal tracts. Based on the study by Michaeli et al[6], Escherichia coli was the most common (71%) organism. In 19% of the cases >1 organism was present. *Aerobacter aerogenes* and *Proteus mirabilis* were isolated in some patients.

Anaerobic bacteria were grown rarely[6]. According to Huang et al, pathogens was identified in 98% of cases. *E.coli* was the commonest (69%) organism isolated, *K. pneumoniae* was the second (31%). 6% had *E.coli* infection along with *Streptococcus spp. o*r *Proteus spp*.; Anaerobic organisms were not obtained[8].

Thus the most common organism grown is *E.coli* followed by *Klebsiella*. *Proteus, Pseudomonas, Aerobacter aerogenes*, *Streptococcus* and rarely anaerobes, *Candida albicans* and *Cryptococcus* may be grown[15].

Diabetes mellitus and EPN: [6,14]

Diabetic patients, characterized as immunocompromised hosts, are particularly susceptible to bacterial infections (Michaeli et al[14]). Emphysematous pyelonephritis (EPN) predominantly manifests in individuals with diabetes mellitus. Michaeli et al. reported that 87% of emphysematous patients had diabetes mellitus. Elevated tissue glucose levels in diabetes serve as a substrate for organisms to produce carbon dioxide and hydrogen through the fermentation of sugar (Michaeli et al[6]). While EPN is chiefly observed in uncontrolled diabetics, Moreover, instances have been reported in non-diabetic patients and Euglycemic managed diabetics. In non-diabetic individuals, the disease tends to be less widespread and is commonly linked to obstruction of the renal-ureteral unit (Michaeli et al[6]).

The role of obstruction of urinary tract [6,8]

Obstruction was found in 40% of EPN patients, as reported by Michaeli et al., supporting the idea that gas formation requires obstruction. Bilateral EPN and EPN in solitary kidneys often presented with urinary tract obstruction. In non-diabetic patients, EPN nearly always correlated with ureteral obstruction. According to Huang et al., 22% of diabetics and all non-diabetics (2 patients) had associated urinary tract obstruction. Left kidneys were more frequently affected by urinary tract obstruction compared to right kidneys (64% vs. 36%)

Pathophysiology

It is said that hyperglycemia is a source for the organisms to produce CO2 and hydrogen via the fermentation of sugar[6]. Two important features found commonly in EPN are necrotizing infection and compromised vascular supply as shown by presence of thrombus in intra renal vessels and renal infarctions.

Theory of Schainuck and associates supports these findings[16,14] emphasizing the importance of impaired tissue and vascular response. Obstruction and diabetic glomerulopathy are local factors and systemic factors such as increased risk of infectious complications associated with diabetes mellitus are all said to be responsible for tissue and vascular damage.

Host response that predisposes to tissue damage is the impaired immune response, not the hyperglycaemia. The impaired host response theory is probable explanation for the presence of EPN in patients without diabetes and in those without evidence of infection.

In patients with diabetes mellitus and EPN both mechanisms (sugar fermentation and defective host response) coexist and explain the origin of profuse gas production[6].

Mechanism of Gas Formation [14-18]

Metabolic energy is required in a constant manner by the growing organism. Fermentation proceeds via the glycolytic (Embden-Meyerhof) pathway, in which two molecules of adenosine triphosphate (ATP) are produced. Pyruvate is generated during the process of conversion of NAD^+ to NADH as end product.

Apart from this several other pathways have been evolved in the microorganism for the reoxidation of NADH by pyruvate or its derivative such as lactic fermentation (*streptococcus*, *lactobacillus*), fermentation of alcohol the substance that is produced by *Enterobacteriaceae spp.* in mixed acid fermentation is stable in non-acidic pH. However the fermentation reactions lead to pH 6 or below due to accumulation of acids. Gas forming microorganism like *E.coli*, will form an enzyme formic hydrogenylase. Formic acid is converted into carbon dioxide and hydrogen by Formic hydrogenylase. The result of mixed acid fermentation is production of hydrogen. None of the other 5 pathways listed above would give rise to hydrogen gas as the end product. Gas composition of a gas bubble tends to equilibrate naturally with the surrounding tissues; hence it is reasonable that the gas will contain reasonable amounts of nitrogen, as well as oxygen, carbon dioxide and hydrogen. Trace amounts of ammonia and methane might arise from the fermentation of mixed amino acids that were produced by the degradation of the necrotic tissues[14].

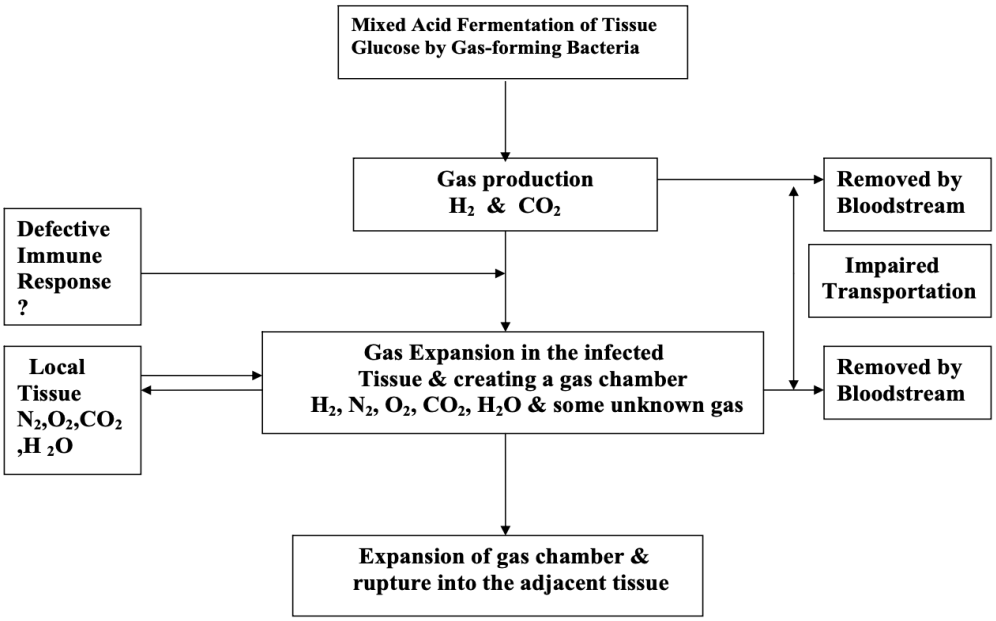
The mechanism of gas formation is proposed to be due to various causes like increased gas formation, delay in clearance of gas by vascular compromise, gas chamber formation, and the expansion or collapse of the gas chamber.

Potential contributing factors to the pathophysiology of EPN are four in number namely gas forming bacteria, high tissue glucose levels, impaired tissue perfusion, and a defective immune response. Hyperglycemia is the cause in diabetes mellitus[14,17,18]. The unrelieved obstruction in case of urinary tract because of back pressure and impaired circulation, results in decreased transportation of gas and subsequent creation of a gas chamber (ie, EPN)[8].

Local tissue damage would markedly interfere with clearance of end products away from the lesion and accumulation of gas occurs. In the non- diabetic also, glucose may serve as the substrate for gas formation. In normal non-diabetics, around 20 mg% of glucose may be present and up to 60 mg% with acute or chronic renal disease. It is said subclinical glucosuria in renal infection may sometimes be enough

to generate enough gas [12 to 36 cc of gas from 100 mg glucose at S.T.P] [2].

Picture 1: Pathogenesis of emphysematous urinary tract infection[8]


Mixed Acid Fermentation of Tissue Glucose by Gas-forming Bacteria
Gas production H_2 & CO_2
Removed by Bloodstream
Defective Immune Response ?
Impaired Transportation
Local Tissue N_2,O_2,CO_2 ,H_2O
Gas Expansion in the infected Tissue & creating a gas chamber H_2, N_2, O_2, CO_2, H_2O & some unknown gas
Removed by Bloodstream
Expansion of gas chamber & rupture into the adjacent tissue

PATHOLOGY

1. Features of inflammation of pelvis and parenchyma
2. Abscesses in cortical region of kidney
3. Papillary necrosis
4. Changes due to decreased tissue circulation – infarction, thrombosis of vessels, arteriosclerosis and glomerulosclerosis.
5. Infiltration of cells associated with inflammation, focal necrosis and abscess formation.
6. Kimmelstiel-Wilson nodules, hyalinized arteriosclerosis and glomerulosclerosis – which are features of diabetic nephropathy.

The inflammatory findings are limited to the kidney in class 2 EPN; in extensive involvement, extension to the perinephric areas is seen.

CLASSIFICATION

Huang[8] et al Classification.

Class 1 – Gas in the collecting system only (Emphysematous pyelitis)

Class 2 – Gas in the renal parenchyma without extension into the extrarenal space

Class 3A- Extension of gas or abscess to the perinephric space

Class 3B- Extension of gas or abscess to the pararenal space

Class 4 – Bilateral EPN/Solitary kidney with EPN[8]

Wan[7] et al

Type I

Renal necrosis with either the presence of a streaky/mottled gas pattern demonstrated on radiograph or total absence of fluid content on CT or CT with lung window display.

Type II

Characterized either by the presence of gas in the collecting system or the presence of renal/perirenal fluid in association with a bubbly/loculated gas pattern.

Type I emphysematous pyelonephritis is associated with more extensive parenchymal necrosis and a more fulminating clinical course than type II[7]

Mitra[15] et al also divided renal emphysema into two distinct entities and proposed to have important prognostic and therapeutic implications.

1. **Emphysematous pyelitis:** A milder form is characterised by gas in the pelvicalyceal system. It is associated with obstructive uropathy[6,19].

2. **Emphysematous pyelonephritis:** Gas in this type extends in addition to renal pelvis, calyx, parenchyma, tissues around kidney and retroperitoneum[15].

Michaeli[6] et al. classification

Stage I - Gas within the renal parenchyma or in the perinephric tissues.

Stage II - Presence of gas in the kidney and its surrounding tissues.

Stage III - Extension of gas through fascia of kidney or Involvement of bilateral EPN.

CLINICAL PRESENTATION

EPN presents commonly in adults[20]. Juvenile diabetes is not a risk factor. Men are less affected than women[21]. The patient presents with features of pyelonephritis that fails to resolve during the first 3 days of treatment. Chronic infection preceding an acute attack is also seen in some cases. Almost all patients present with any two of the classic

triad of fever, vomiting and flank pain and pyuria[16]. Many also show non-specific symptoms, such as pain in the abdomen, nausea, vomiting and altered sensorium. It accompanies shock, lumbar tenderness, dysuria, crackling feel in the flanks, and pneumaturia[2-4,6,9]. When infection involves the collecting system pneumaturia is present. Culture test of urine is invariably positive. Most often organism identified is E.coli; Klebsiella and Proteus are less common. Huang et al founded fever in 79%, nausea/vomiting in 17%, shock in 29%, alteration in conscious level in 19% and acute renal functional impairment in 35% of cases[8].

Michaeli, in his study of 55 patients found chills, fever (57%), flank pain (46%), lethargy and confusion(22%), Nausea preceding vomiting (14%), shock and coma (14%). Pyrexia of unknown origin was the presenting feature in some 18%. Pneumaturia is uncommon. The average duration of all these symptoms was 21 days; ranging from 0.5 to 240 days before diagnosis[6].

Diabetes has higher incidence of EPN - 80% (Shokeir et al[12]), 96% (Huang et al[8]), and 87% (Michaeli et al[6]). 25 The preferable side of involvement was predominantly left (60% in Shokeir et al's study12 and 47% (Bum Soo Park et al)[5]. Affection of both kidneys also ranged from 5%[12] to 20%[22].

The clinical sign is costovertebral angle tenderness[5]. Leukocytosis present in about 67% and thrombocytopenia is seen in 46%[8]. Patients may present in medical emergency causality viz., diabetic ketoacidosis.

MICROBIOLOGY

The commonest reported organism is E. Coli (69% to 73%) followed by Klebsiella (27%)[8,6]. Blood stream involvement by bacteria is found in almost 50% of all the cases and usually the organisms that are grown in urine, blood and tissue cultures matches it[8,12]. 19% of cases show more than one organism[6].

RADIOLOGY

The definitive mode of diagnosis of EPN is by imaging radiology. Radiology helps to confirm the presence of EPN and classify EPN hence guiding the treatment and assessment of prognosis of the

disease. It is investigated by X-ray, USG and CT scan. Best early pick up rate is by CT.

Extent of gas dissemination is defined with great accuracy. It stages the gas distribution and facilitates description of the gas in the renal system as streaky, mottled, bubbly, rim like, crescent shaped, locular, etc. CT helps in diagnosis and follow up. It picks up the development of new lesions as well, resolution of the gas and abscesses.

The USG, though not sensitive in identifying renal gas helps in diagnosis obstruction of urinary tract. Intraparenchymal gas is shown as strong focal echoes [8,23,24]. The “dirty” white shadows are diagnostic whereas “clean” shadowing is due to calculus. USG is cheap, readily available and non-invasive.

Plain X-ray of the KUB region shows gas distribution in the renal and perirenal areas in 33% of cases. One may differentiate renal gas from overlying intestinal gas in equivocal cases by Infusion nephrotomography[6]. Differential diagnosis of gas in EPN is traumatic renal infarction. IVU [Intravenous urogram] demonstrates absence of excretion of kidney in 27 around 45%. Even those who showed excretion, had poor delineation. Due to the toxic side effects of contrast in IVU on the kidneys in diabetics and as not much information is provided by it because of non-functioning or poorly functioning system on affected side, Its use should be considered carefully. Compared to plain CT, IVU shows gas and other findings such as areas of renal inflammation like indistinct margins and mass effect[12].

Obstruction is demonstrated in around 25% of cases; and is better demonstrated by USG or retrograde pyelogram. 3 main patterns of findings on X-rays described by Langston and Pfister had an apparent similarity with the stage of the disease. Earliest sign is diffuse mottled appearance of the renal parenchyma, with radial distribution of the gas bubbles either along the pyramids or within the tubules. Bubbly parenchyma with crescent of gas denotes further clinical deterioration. With extension through the Gerota’s fascia, gas can be seen in the

retroperitoneum and may even extend up to the posterior thoracic wall[25].

Bum Soo Park et al found plain Xray KUB as reliable modality of screening investigation (picked up 50% of cases) and CT as the most reliable modality for diagnosis confirmation (Diagnostic rate 100%) for planning treatment. According to him USG unhelpful to locate renal gas[5].

MANAGEMENT

All patients invariably need supportive resuscitative measures as patient is acutely ill. Intensive measures aimed at glycaemic control by insulin, maintenance of fluid balance by serial electrolyte level monitoring and treatment of shock as quickly as possible. Antibiotics can be changed later according to sensitivity once culture reports are available but beforehand empirical antibiotic is started immediately. Obstruction, if present, should be relieved urgently.

Joseph.B.Stokes JR[26], Dunn and Dewolf et al, in their study of 3 cases treated by nephrectomy[27] favoured an initial trial of conservative management with antibiotics. According to Schultz and Klorfein, the disease is best managed by intensive medical methods of treatment and is not an indication of emergency surgery. They found that involvement of contralateral kidney was often present and really nephrectomy is unwarranted[2]. Their main concern was the probability of recurrent disease in the contralateral kidney.

Nephrectomy could be considered if the renal and perirenal gas or the toxic symptom persists in spite of conservative management. Such patients may even be started on lifelong suppressive antibiotics and be followed up strictly instead of nephrectomy. Medical management of EPN is preferable because of high chances of involvement of opposite kidney due to disease recurrence as well as diabetic disease. Avoidance of surgery, vigorous blood sugar control, appropriate antibiotics and relief of obstruction was considered as rational therapy.

During previous days treatment ideas were that mere medical treatment does not decrease mortality or morbidity hence

supplemented by prompt surgical drainage and nephrectomy. Renal conservation has come into vogue for reasons already mentioned. Need to save the kidney in the setting of a high probability of the disease occurring in the opposite side later as well as the long-term effects of diabetes on the opposite kidney. In conditions like synchronous bilateral disease as well as EPN affecting a solitary kidney this modality of minimal invasive procedures with renal conservation is highly desirable.

The importance of perinephric extension of gas was insisted by Huang et al[8]. Even though the differences in clinical presentations are not that much different between classes, mortality and failure of PCD tends to increase from class 1 to 4. The best prognosis was enjoyed by class 1 patients. PCD and antibiotics with relief of obstruction keeps these patients recovering.

In class 2 also, all patients treated so, were shown recovery. In class 3 and 4 morbidity is based on the presence of risk factors. In presence of less than two risk factors favourable response increased when subjected to PCD and antibiotic. 85% of patients with <2 risk factors (reduced platelet count, decreased renal function, alteration in consciousness and low blood pressure) showed renal conservation.

The failure rate of conservative treatment (i.e., combined medical and minimally invasive treatment) was less for those with no or single risk factor, failure rate was 15% for those with no or a single risk factor; and 92% for those with 2 or more risk factors. In such cases, nephrectomy is expected to give the best management outcome. The usefulness of PCD as it drains the pus, releases the gas and thereby the pressure to local circulation is relieved and improves circulation, provides pus that can be cultured and can help in further management and can promote increased rates of success in extensive EPN.

They suggest PCD and antibiotics less extensive disease (class 1 & 2) and for extensive EPN with < 2 risk factors. This leads to a renal conservation in most of the cases.

Nephrectomy provided the best treatment outcome for extensive EPN with fulminant course (2 or more risk factors). Even in class IV drainage

of gas is attempted first. Emergency nephrectomy in such individuals carries poor prognosis and increased mortality. Nephrectomy should be done if PCD fails. Prognostic factor do not include poor glycemic control. Multiple organ dysfunction in EPN affects outcome of treatment as disease runs a rapid progression with poor outcome. Severe proteinuria also carried poor outcome and seemed to be involved in extensive disease. The causes of severe proteinuria may be multifactorial with fever underlying glomerulonephritis, and diabetic nephropathy may contribute.

Michaeli et al[6], in their review, is of the opinion that renal conservation were often not successful whereas bilateral surgery was successful at times. Thus most important factor associated with survival was an approach combining medical and surgical treatment. The observation is the most favourable outlook of minimally invasive surgery was for individuals with non-obstructive unilateral disease and short interval of symptoms of EPN.

Wan[7] et al described two classes of EPN. The dry type (type 1) which is associated with parenchyma destruction, absence of fluid collection and streaky or mottled gas presented a fulminant course with a mortality rate of 66%. Type 2 is associated with a mortality rate of 18%. This difference in observation is due to compromise in immunity and vascular insufficiency in the kidneys and immunocompromise in the diabetics. They described serum creatinine > 1.4mg% was associated with a poor outcome. In their study of 20 cases, Shokeir et al[12] is in for nephrectomy which is scheduled immediately follow aggressive resuscitation and diabetes control. Stein et al, in their case report and review of literature[22], insisted on treatment of bilateral disease in multiple ways and combination. Endoscopic stenting, PCD bilaterally / unilaterally which includes PCN both sides or single sides depending on extensive involvement and stenting. Nephrectomy ipsilateral and open drainage was decided according to progress.

Few others also considered nephrectomy to be the most effective modality of treating EPN as evidenced by Bum Soo Park et al[5]. They were for concomitant immediate nephrectomy and all supportive and

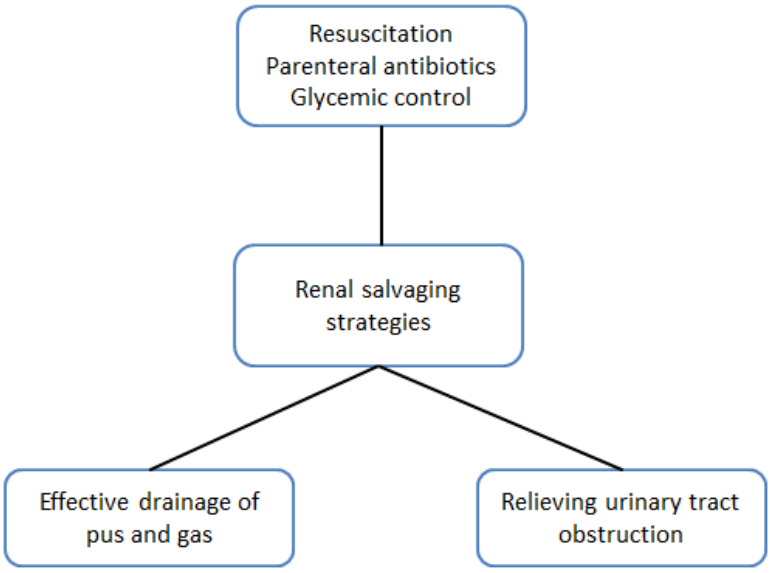
resuscitative measures. Renal conservation (with PCD and antibiotics) was aimed in solitary kidney, poor general/medical condition rendering the patient unfit for surgery, inadequate function of other kidney and disease of bilateral kidney.

Nephrectomy is done through 11th rib bed approach through the loin. Hung et al[29] have noted anaerobic bacteria, B. fragilis as the causative organism in a case of EPN. According to him anaerobes are never a causative pathogen; rarely one case has been reported with clostridium[30]. Anaerobes also cause EPN and hence anti-anaerobic antimicrobial treatment is needed.

During recent past few decades, the management strategy has gradually shifted toward renal salvage approaches such as percutaneous drainage (PCD) or double J stenting (DJS) along with parenteral antibiotic coverage[31]. Such management strategies resulted in a significant drop in the mortality rate to 21%[31]. However, nephrectomy is still being considered as a first-line modality, particularly in higher grades of EPN with the presence of high-risk prognostic factors[31]. There is no consensus on the effective management of EPN till date[31].

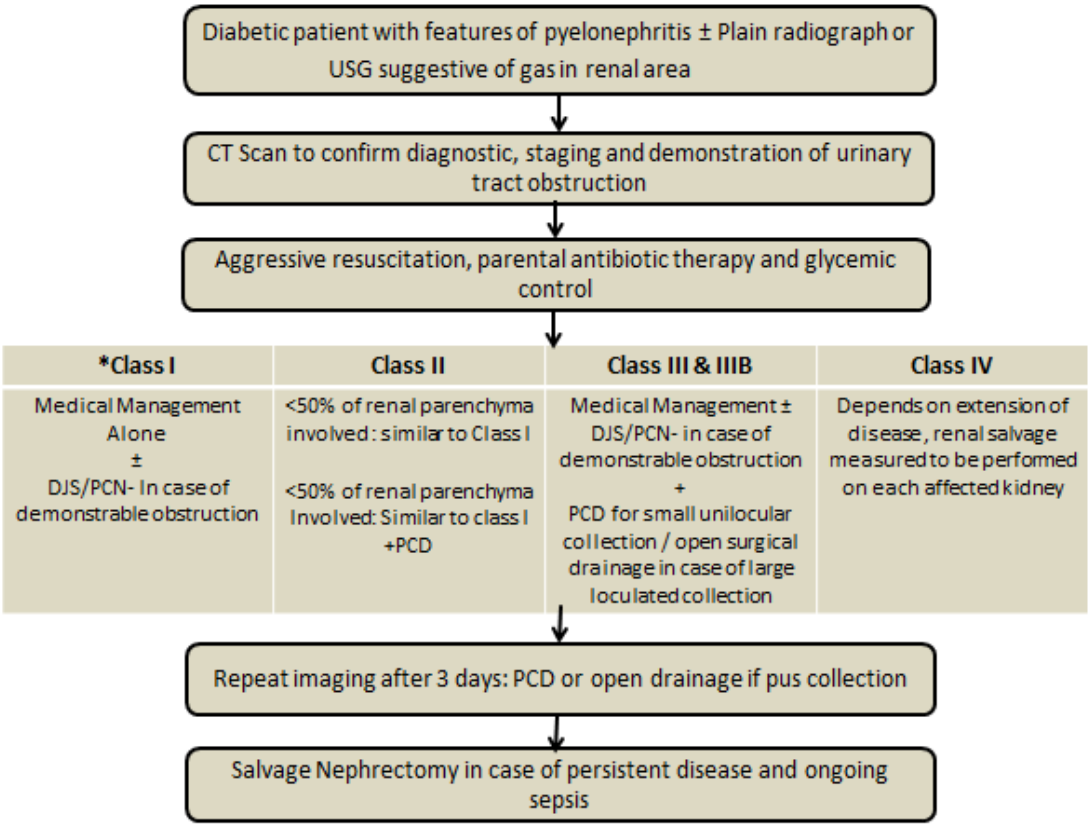
Study by *Adapala [31] RR et al.* given *following* algorithms for management of EPN as shown in following flowchart.

Picture 2: Various initial renal salvage strategies in the management of EPN



EPN in conjunction with ADPKD is exceedingly rare, with only four cases having been previously reported. While there have been reports of concurrent EPN and emphysematous cystitis, this is the first documented case of both bilateral EPN and emphysematous cystitis occurring together in the context of ADPKD[32]. The cause of EPN in ADPKD remains unclear. It has been suggested that preexisting damaged renal tissue and impaired blood supply may contribute to its development, as some bacteria can utilize necrotic tissue as a substrate for gas production[32]. Hyperglycemia in septic diabetic patients and a compromised immune response promote bacterial overgrowth[32]. Ureteral instrumentation, which can result in the seeding of bacteria into cysts, has also been reported as a cause in one case[32]. Mortality rates are reported at 20% for unilateral EPN and 50% for bilateral EPN, highlighting the importance of appropriate management[32].

Picture 3: Algorithm of renal salvage protocol in EPN


Diabetic patient with features of pyelonephritis ± Plain radiograph or USG suggestive of gas in renal area
CT Scan to confirm diagnostic, staging and demonstration of urinary tract obstruction
Aggressive resuscitation, parental antibiotic therapy and glycemic control
*Class I
Medical Management Alone ± DJS/PCN- In case of demonstrable obstruction
Class II
<50% of renal parenchyma involved: similar to Class I
<50% of renal parenchyma Involved: Similar to class I +PCD
Class III & IIIB
Medical Management ± DJS/PCN- in case of demonstrable obstruction + PCD for small unilocular collection / open surgical drainage in case of large loculated collection
Class IV
Depends on extension of disease, renal salvage measured to be performed on each affected kidney
Repeat imaging after 3 days: PCD or open drainage if pus collection
Salvage Nephrectomy in case of persistent disease and ongoing sepsis

Key factors for successful medical management include early diagnosis, absence of obstructive uropathy, and adequate perfusion as seen on renal flow scans. The persistence of localized gas within the renal parenchyma or pyelocalyceal system should not necessarily be viewed as a negative indicator[32]. Huang[8] and Tseng[32] suggested that in patients with localized EPN or extensive EPN showing a more benign presentation (fewer than two of the following risk factors: thrombocytopenia, acute renal impairment, altered consciousness, or shock), treatment typically involves antibiotic therapy combined with percutaneous catheter drainage if needed. Among the four reported cases of EPN in patients with ADPKD, treatment approaches varied: one underwent bilateral nephrectomy, one had unilateral nephrectomy, one was managed conservatively, and the approach was not specified for the fourth case [32]. In the early phase of EPN, when the patient is hemodynamically stable, conservative management can be effective. However, close monitoring is essential—both clinically and through radiological evaluations. Percutaneous catheter drainage or surgical intervention should be employed as needed based on the patient's condition.

A study by Aggarwal D[33], Management of emphysematous pyelonephritis (EPN) has significantly evolved over the past twenty years. Failure to manage EPN promptly and effectively can lead to severe complications and even death. Historically, the treatment approach focused on immediate surgical intervention, such as nephrectomy or open surgical drainage, coupled with aggressive resuscitation. However, surgery often has poor outcomes in EPN patients due to compromised hemodynamic and nutritional status, underlying comorbidities, and septic shock. Reports indicate that aggressive surgical approaches have mortality rates as high as 40%–50%. For instance, Ahlering et al. reported a 42% mortality rate with emergency nephrectomy. Kapoor et al. found that early nephrectomy often resulted in higher mortality compared to an initial conservative approach, while surgery considered only if absolutely necessary. In their study, only 5.4% of patients underwent immediate nephrectomy,

while most were managed with broad-spectrum intravenous antibiotics and percutaneous drainage—27.7% with antibiotics alone and 60.7% with pigtail drainage. A meta-analysis by Aboumarzouk et al. further confirmed that percutaneous drainage and medical management are associated with significantly lower mortality compared to emergency nephrectomy.

Another crucial aspect of the non-surgical approach is its application in cases of bilateral EPN. About 5% of patients with EPN have bilateral involvement, and nephrectomy in such cases would require lifelong renal replacement therapy. Of the six patients with bilateral EPN, five responded well to medical treatment or percutaneous catheter drainage. One patient, however, succumbed due to refractory hypotension, acute kidney injury, and diabetic ketoacidosis. Previous case reports have also documented successful non-surgical management of bilateral EPN.

The renal parenchyma destruction caused by EPN often results in diminished kidney function. Aswathaman et al. reported a 10% rate of elective nephrectomy among 41 EPN patients during follow-up. For those not undergoing nephrectomy, the mean relative function of the affected kidney was 42% (ranging from 19% to 60%). Given the reduction in mortality over time, preserving renal function has become a crucial consideration in managing EPN. Kapoor et al. identified factors predicting the need for delayed nephrectomy, finding that more than 50% parenchymal destruction on CT imaging was a significant predictor. Among 99 patients with preserved kidneys, 12 required elective nephrectomy due to non-functional kidneys on renal dynamic scans. The study found that a renal parenchymal thickness of less than 5 mm on CT imaging was a significant predictor of the need for delayed nephrectomy ($p=0.001$). These findings are valuable for guiding decision-making and planning in EPN management, helping to predict mortality risks and the necessity for follow-up nephrectomy.

MATERIALS AND METHODS

STUDY DESIGN –

The study design was a prospective observational study conducted in tertiary care institute in state of Punjab.

Ethical Committee permission from the Institute was obtained before launching the study.

SAMPLE SIZE – This study was a time bound study between month of September 2022 to August 2024. All the patients admitted in the given time frame will be included in the study.

SOURCE OF DATA:

The study was conducted among the patients admitted in various departments of Dayanand Medical College and Hospital, Ludhiana from 1st sept 2022 to 1st Aug 2024.

Information collected through a pre- designed Performa for each patient chosen to be a part of the study with detailed and through history, clinical examination and complete investigational workup. Details of the study explained to each patient included in the study. We conducted analysis using the gathered data in a prospective manner. Every participant in the study gave their prior informed consent.

METHOD OF COLLECTION OF DATA:

- Patients admitted in different departments like urology, nephrology, medicine of our institute were included in the given study.
- Patients of either gender with unilateral or bilateral EPN willing to participate in the present study and not having any below mentioned exclusion criteria will be included in the study.
- Detailed demographic characteristics like age, gender, address, occupation of each patient were noted in the proforma.
- All the patients asked about their chief complaints in order of chronology to arrive at provisional diagnosis of EPN.
- Enquiry about duration of and treatment for diabetes mellitus and other comorbidities like Hypertension, coronary artery disease, chronic kidney diseases, h/o stone disease in past and any

intervention done recorded. Details of current or past medications of each patient noted, any allergy to specific drug were documented and highlighted over treatment charts.

- After admission to ward, ICU baseline vital parameters like heart rate, blood pressure, respiratory rate, saturation at room air or need for oxygen support, random blood sugars and urine ketone were noted. Baseline routine blood investigations like hemogram, renal function test, liver function test, viral markers (hepatitis B/ hepatitis C /HIV), markers of inflammation like C reactive protein (CRP) and procalcitonin (PCT) level were sent for all patients with signs of sepsis. Urine routine and microscopy with cultures and blood culture during episode of fever sent for all the patients.
- After arriving at provisional diagnosis of urinary tract infection patient were underwent preliminary USG abdomen with particular focus on KUB region to look for concerned pathology.
- If findings suspicious of gas in or around kidney were present, patients underwent CT KUB (non-contrast or with contrast enhancement if indicated). Patients in whom gas could not be identified in either of these modalities underwent CT KUB based on clinical suspicion due to toxic clinical features.
- The patients were stratified based on Huang[8] et al's CT classification.
    - **Class 1** – Gas in the collecting system only (Emphysematous pyelitis)
    - **Class 2** – Gas in the renal parenchyma without extension into the extrarenal space
    - **Class 3A**- Extension of gas or abscess to the perinephric space
    - **Class 3B**- Extension of gas or abscess to the pararenal space
    - **Class 4** – Bilateral EPN/Solitary kidney with EPN
- Shock was defined as systolic BP <90 mm Hg. Raised renal parameter was defined as serum creatinine > 1.5 mg% or blood

urea >40mg%. Altered consciousness was defined as patient in fully conscious, drowsy, stupor or coma.

- All patients were started on 3rd generation cephalosporins (cefotaxime, ceftriaxone or cefoperazone) and metrogyl. Aminoglycosides were added if renal parameters were normal after antibiotic sensitivity testing.
- Antibiotics were later changed if necessary, based on urine /blood culture and sensitivity reports. Vigorous resuscitation was carried out with hydration, correction of electrolyte imbalance if any and diabetes control measures was initiated with insulin in all the cases.
- All patients were stratified to initially undergo conservative management with only antibiotics, antibiotics with PCD &/or DJ stenting. PCD was defined as percutaneous aspiration of pus and gas with/without percutaneous nephrostomy(PCN).
- Patients with air in renal collecting system and fit to undergo surgery in operation theatre were taken up for emergency DJ stenting under anaesthesia. Those patients who are admitted in ICU with multiple lifesaving supports ionotropic support, ventilatory support or those who are poor candidates for surgery under anaesthesia were underwent percutaneous nephrostomy (PCN) under Local anaesthesia by interventional radiologist to drain out air/ pus from emphysematous kidney.
- PCN was done under USG guidance using 10 or 12 Fr single puncture nephrostomy catheter in prone, prone oblique or lateral positions via the flank taking care to avoid contamination of the peritoneum.
- Those patients with significant perinephric collection (class 3) were underwent percutaneous drainage (PCD) to drain the air, pus from the area adjacent to the kidney other than colleting system.

- Successful intervention defined as improvement of clinical condition in the form of improvement of symptoms like fever along with improvement in blood parameters (TLC, serum creatinine), weaning of lifesaving supports. Once patient shows signs of improvement they were shifted to ward for further management.
- Patients with PCN tube in situ and with signs of clinical recovery were taken up for DJ stenting under anaesthesia and discharged with DJ stent for prolonged drainage of collecting system after removing PCN.
- Switching from external drainage (percutaneous nephrostomy or PCN) to internal drainage (double-J stent) was crucial because managing an external tube (PCN) at home can be challenging and cumbersome. In contrast, a double-J stent requires no special precautions and is much easier to manage.
- Unsuccessful intervention (PCN/DJ stenting +/- PCD) was defined as progressive or persistent lesions on radiological studies with a clinical picture of unstable hemodynamic status or prolonged fever after management.
- Patients who showed no signs of clinical improvement or experienced further deterioration despite initial treatment with intravenous antibiotics and minimally invasive interventions (such as percutaneous nephrostomy (PCN), double-J stenting, or percutaneous catheter drainage (PCD) were scheduled for elective nephrectomy. This decision was made after obtaining informed and written consent from the patients' attendants, with a detailed explanation of the prognosis provided.
- Our patients, depending on outcome, were stratified into the "discharged and resolution of EPN (good outcome) " and "death (poor outcome)" groups. The "good" outcome group included patients treated with antibiotics only or PCD +/- DJ stenting or DJ stenting only with antibiotics. The "poor" outcome group included patients who had unsuccessful PCD followed by nephrectomy or

mortality. Patients will be followed at 2 month interval to check for response to treatment.

INCLUSION CRITERIA

- Age ≥ 18 of either gender.
- Patients admitted based on clinical features and documentation of gas within the renal system on CT scan.

EXCLUSION CRITERIA

- History of recent endoscopic or open interventions or recent catheterization of the urinary tract.
- Any fistula between the bowel and urinary tract.
- Recent urinary trauma.

OUTCOME- The study aims to know whether minimally invasive treatments such as PCD +/- DJ stenting/PCN play a significant role in renal conservation compared to traditional nephrectomy. Minimally invasive procedures have shown limited morbidity and comparable treatment efficacy to surgery (nephrectomy).

OBSERVATION AND RESULTS

Emphysematous pyelonephritis (EPN) represents a severe, life-threatening renal infection characterized by the presence of gas within the renal parenchyma or collecting system. This condition, although relatively rare, poses a significant challenge due to its rapid progression and high morbidity and mortality rates. The disease can affect individuals across a wide spectrum of ages and genders, often complicating the clinical picture.

In our comprehensive study involving 35 patients, we aimed to elucidate the demographic, clinical, prognostic characteristics and management of EPN, thereby enhancing the understanding of this formidable condition. The following results provide critical insights into the presentation, management, and outcomes of EPN, shedding light on its impact across diverse patient profiles and contributing to the broader discourse on optimal therapeutic strategies.

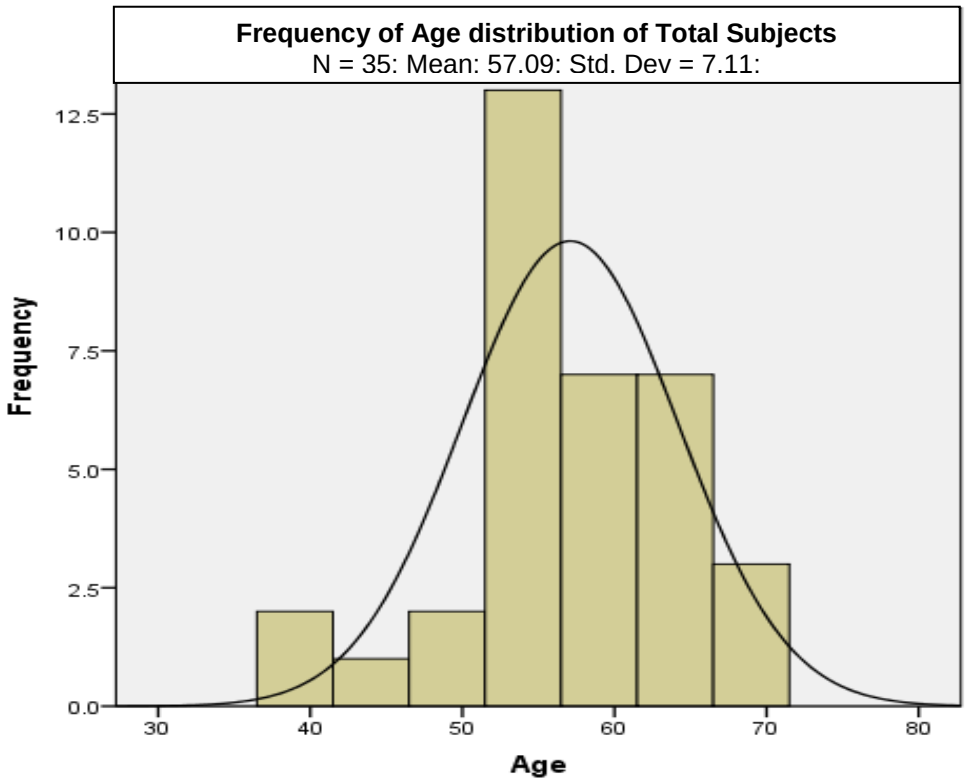
A. AGE AND GENDER:

The present study conducted between September 2022 to August 2024 at Dayanand Medical College and Hospital, Ludhiana, enrolled total thirty five (35) patients; out of which Female were 23 (66%) and Male were 12 (34%). The data was normally distributed; and no significant difference in the age of two groups was observed as is shown in table no 1, and graph no 1 and graph no 2.

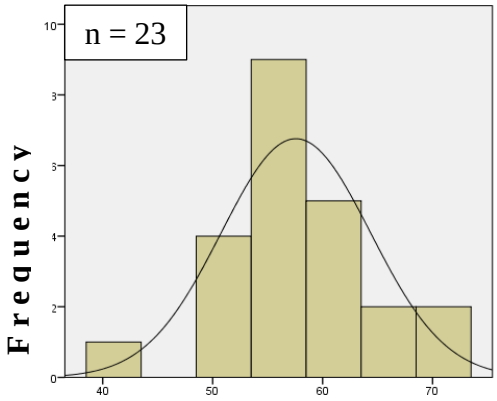
Table 1: Age distribution of Study Subjects

Age in yrs.	N	Mean	Std. Deviation	p value
Female	23	57.57	6.78	0.58
Male	12	56.17	7.91	
Total	35	57.09	7.11	

Graph no. 1: Age distribution of study subjects

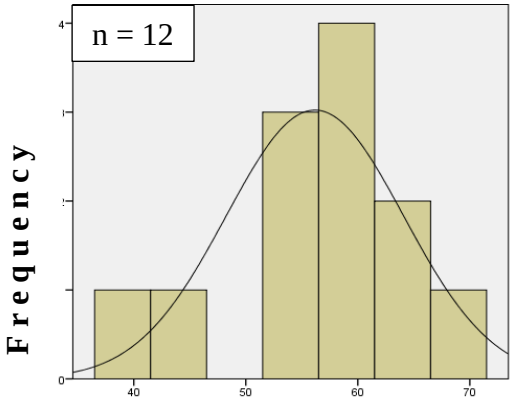


Graph No 2: Age distribution in Female and Male Patients



40 50 60

Histograph Showing Age Distribution in Female subjects: Mean Age 57.57



40 50 60

Histograph Showing Age Distribution in Male subjects: Mean Age: 56.17 yrs.

Stratified age wise distribution showed maximum no. of patients in age group of 51 to 60 yrs.; in Female 12 (52%) and in Male 7 (58%) as shown in table 2.

Table 2: Stratified Age distribution of study subjects

Age group in yrs.	**Total subjects**		**Female**		**Male**	
	N	%	n	%	n	%
31 - 40	1	3	0	0	1	8.3
41 - 50	4	11	3	13	1	8.3
51 - 60	**19**	**54**	**12**	**52**	**7**	**58**
61 - 70	11	32	8	35	3	25
Total	**35**	**100**	**23**	**100**	**12**	**100**

B. CLINICAL FEATURES:

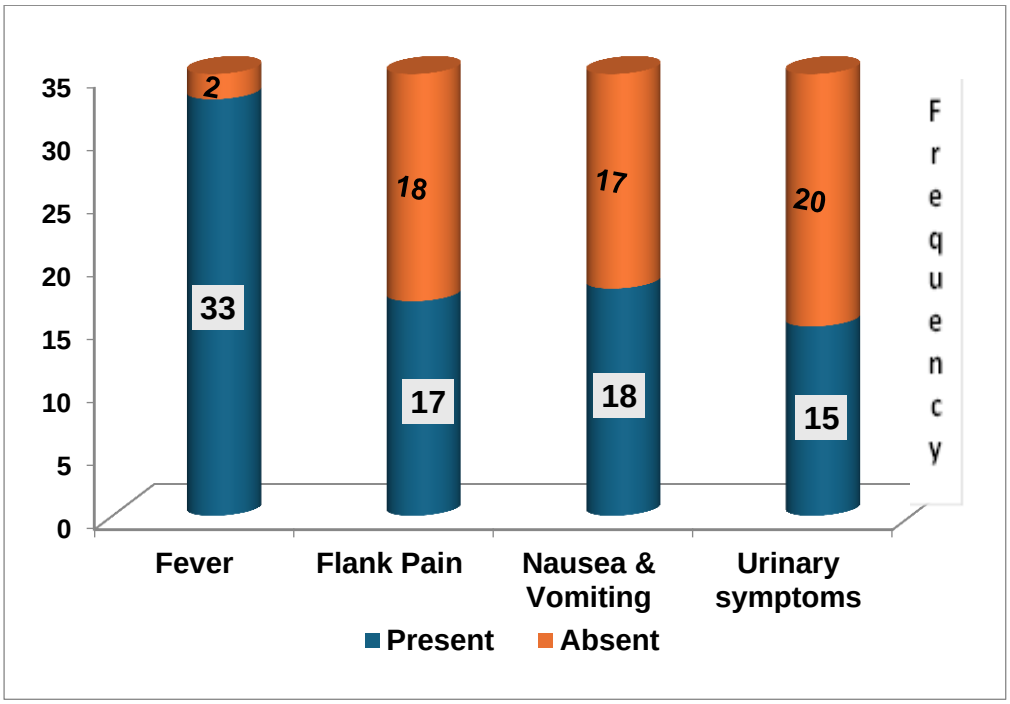
The commonest symptom observed in present study is Fever followed by Nausea, vomiting and Flank pain present in almost half of the patients. Urinary symptoms (burning micturition, dysuria and lower urinary tract symptoms etc.) and Generalized Weakness seen less frequently. Different symptoms are shown in table no 3.

Symptoms were for more than seven days in 45 % of subjects and less than seven days in 55% of subjects. Symptom duration < 7 days considered as acute disease presentation. In the present study most common presentation is acute in onset i.e. < 7 days duration.

Table no. 3: Showing frequency and percentage of Symptoms in 35 subjects

Symptoms	**N = 35**	**Percentage**
Fever	33	94%
Nausea & Vomiting	18	51%
Flank Pain	17	49%
Urinary symptoms	15	43%
Other		
Anorexia	1	3%
H/o of Urosepsis	2	6%
k/c/o Ca Breast Post MRM (modified radical mastectomy), & post Chemotherapy	1	3%
Weakness, Anorexia	7	20%
Weight Loss	2	6%

Graph no. 3: Showing frequency of Symptoms in 35 subjects



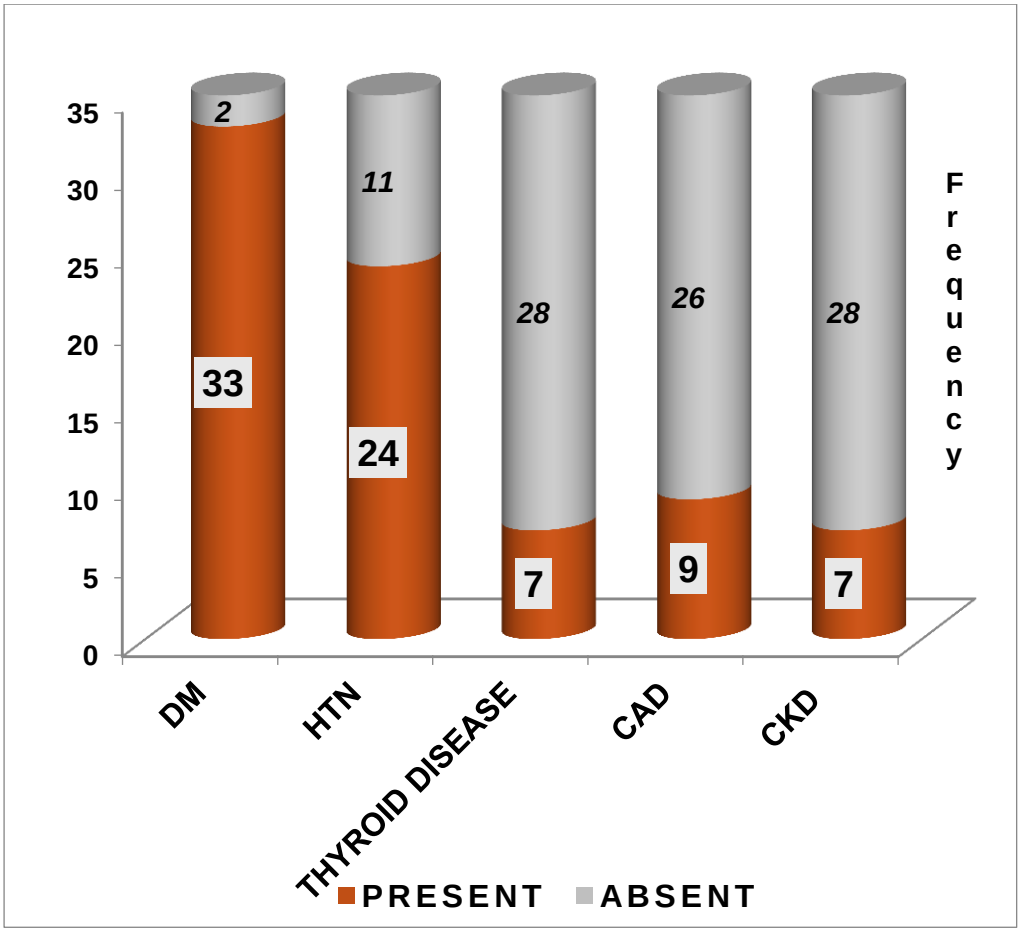
C. COMORBIDITIES:

Most common Comorbidities revealed in present study were Diabetes mellitus in 94 %, and Hypertension in 68% of patients. However Coronary artery disease, Chronic Kidney disease, and Thyroid disorders were seen in 26, 20, and 20 per cent of patients respectively. The difference was statistically significant, $p < 0.001$, as shown in table no. 4 and Graph no. 4. At the same time Odds ratio between Diabetes mellitus and Hypertension as responsible comorbidities is 7.56; there by suggesting that DM is 7.56 times more responsible comorbidity for EPN as compared to hypertension.

Table No. 4: Frequency and Percentage of Comorbidities

N = 35	Present	Absent	Total
	n (%)	n (%)	
Diabetes mellitus	33 (94)	2 (6)	35
Hypertension	24 (68)	11 (32)	35
Thyroid disorders	7 {20)	28 (80)	35
Coronary art. Disease [CAD]	9 (26)	26 (74)	35
Chronic Kidney Disease (CKD)	7 (20)	28 (80)	35
Total	79	96	175
Chi-Sq = 64.9, DF = 4, P-Value = 0.001			
Odd's ratio between DM & HTN = 7.56; **Odd's ratio between HTN & thyroid disorders = 8.73** **Odd's ratio between thyroid disorders & CAD = 0.72** **Odd's ratio between CAD & CKD = 1.38**			

Graph no. 4: Showing frequency of Co-morbidities



Above table no. 4 and graph no. 4 suggest highest association of DM and HTN with Emphysematous Pyelonephritis.

As diabetes is most commonly associated comorbidity in present study we studies value of glycosylated Haemoglobin amongst different grades of EPN classifies according to CT and found that mean HbA1c is 9.74 $\pm$ 2.35 in DM present group. Only 2 subjects did not have DM with mean HbA1c of 5.45. Table no 5 (a & b) demonstrated different grades of EPN with mean HbA1c level and it shows no significant relation with levels of HbA1c, p = 0.2

Table no. 5a: HbA1c levels in different grades of EPN

Grades of EPN	HbA1c LEVEL		
	N	**Mean**	**SD**
I	9	10.8	1.9
II	9	8.89	2.6
IIIa	8	8.58	1.1
IIIb	8	10.94	3.2
IV	1	5.60	-
Total	35	9.50	2.49

Table no. 5b: HbA1c levels in Two groups with different grades of EPN clubbed

Grades of EPN	HbA1c LEVEL		
	n	**Mean**	**SD**
Gr. A (I & II)	18	10.03	2.18
Gr, B (IIIa + IIIb + IV)	17	8.94	2.74
Mean Diff. = 1.09 ; student t test: t = 1.3 ; df = 33, p = 0.2 (not significant)			

D. VITAL PARAMETER

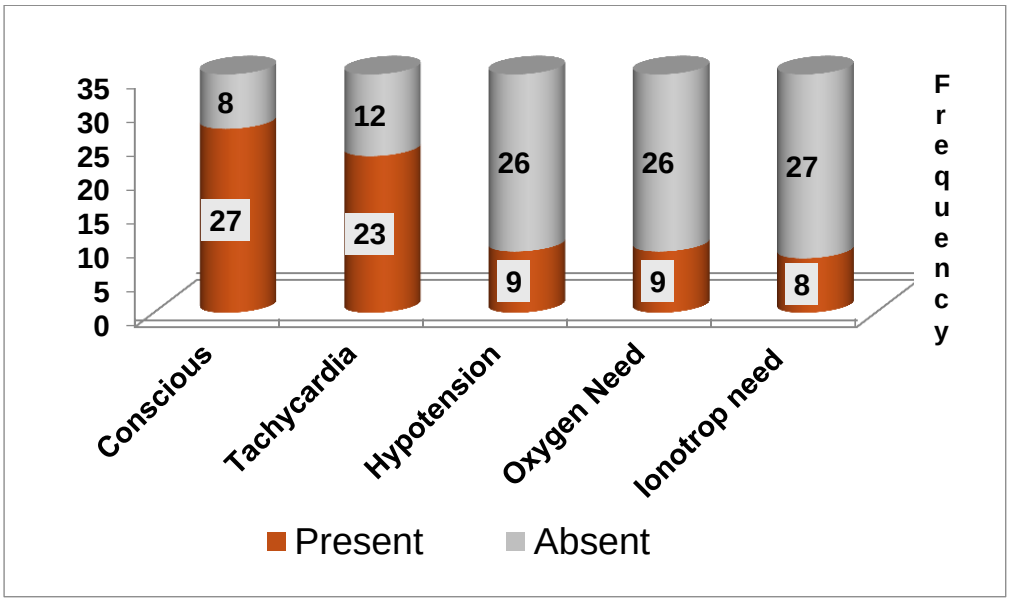
Patients with diagnosis of EPN admitted either in wards or ICU based on general condition and vital parameters on presentation.

As shown in Table no. 6, and Graph no. 5, Tachycardia (HR > 100/min) was found in 66% of EPN patients as predominant sign. Drowsiness, Hypotension, need for Oxygen & Ionotropic support was seen only in 23, 26, 26, 23 per cent of EPN patients in the present study; indicating no clinical relevance of such at risk factors association with EPN patients.

Table no. 6: Showing frequency and percentage of at risk factors for EPN

N = 35	**Present**	**Absent**	**Total**
	n (%)	**n** (%)	
State of Consciousness (Conscious = Present; Absent = Drowsiness)	27(77)	8 (23)	35
Tachycardia	23 (66)	12 (34)	35
Hypotension	9 {26)	26 (74)	35
Oxygen Need	9 (26)	26 (74)	35
Ionotropic need	8 (23)	27 (77)	35
Total	76	99	175
Chi-Sq = 38.238, DF = 4, P-Value = 0.001			

Graph no . 5: Showing frequency of at risk factors for EPN

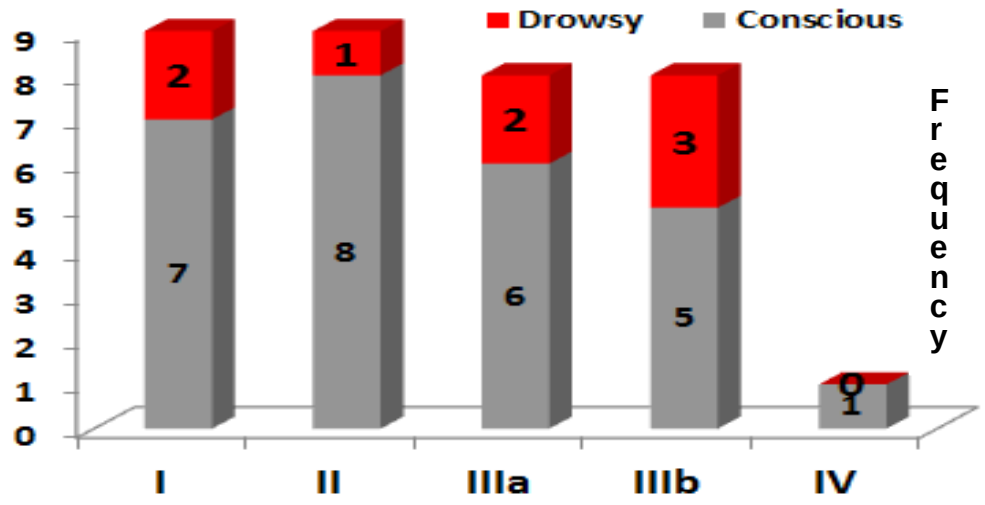


we further studied state of consciousness among different grades of and found that level of consciousness does not depend on grade of EPN, patient in grade 1 EPN can be present with altered consciousness or patient with grade 4 EPN can be fully conscious. Distribution of state of consciousness vs grade shown in table 7 and graph no 6.

Table no. 7: Distribution of State of consciousness vs. Grades of EPN

Grades of EPN	STATE OF CONSCIOUSNESS		Total
	Conscious n (%)	Drowsy n (%)	
I	7 (20)	2 (6%)	9 (26%)
II	8 (23)	1 (3%)	9 (26%)
IIIa	6 (17)	2 (6%)	8 (23%)
IIIb	5 (14)	3 (9%)	8 (23%)
IV	1 (3)	0	1 (3 %)
Total	27	8 (%)	35 (100%)
Chi sq. = 1.99; df = 4, p = 0.73.			

Graph no.6: Distribution of State of consciousness vs. Grades of EPN



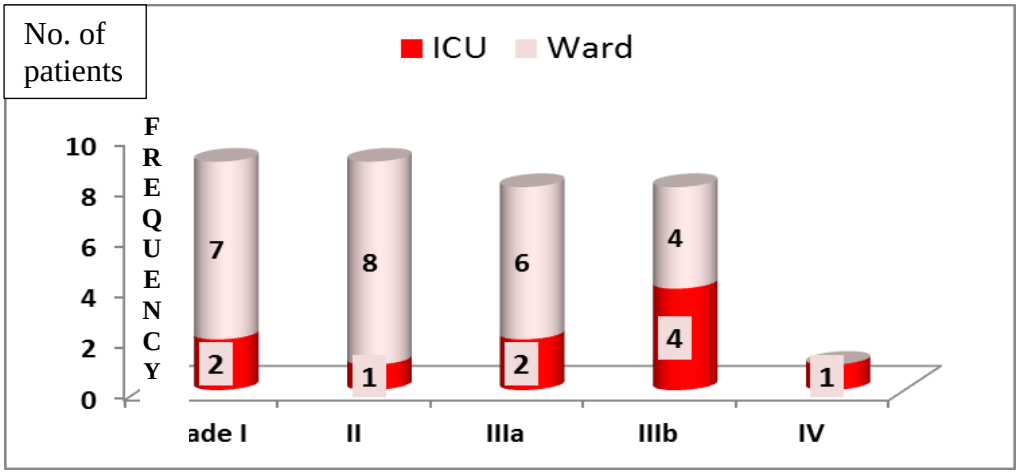
Grades of Emphysematous Pyelonephritis

Patient with EPN admitted in wards or ICU based of general condition and vital parameters. We studies number of patients with different grades of EPN requiring ward/ICU admission, out of total more than 2/3rd patients are stable and required ward admission and rest of the patients admitted in ICU. (28.6%). Frequency and percentages of Ward vs ICU admissions with different grades of EPN shown in table 8 and graph no 7.

Table no. 8: Frequency and percentages of Ward vs ICU admissions in subjects with different grades of EPN

ICU / WARD		**CT wise Grades of EPN**					**Total**
		Grade I	II	IIIa	IIIb	IV	
ICU	No. (n)	2	1	2	4	1	10
	Percentage	5.7%	2.9%	5.7%	11.4%	2.9%	28.6%
WARD	No. (n)	7	8	6	4	0	25
	Percentage	20.0%	22.9%	17.1%	11.4%	0.0%	71.4%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 5.87; df = 4; p = 0.2 (Not significant)							

Graph no. 7: Showing no. of Ward vs ICU admissions in Subjects with different grades of EPN



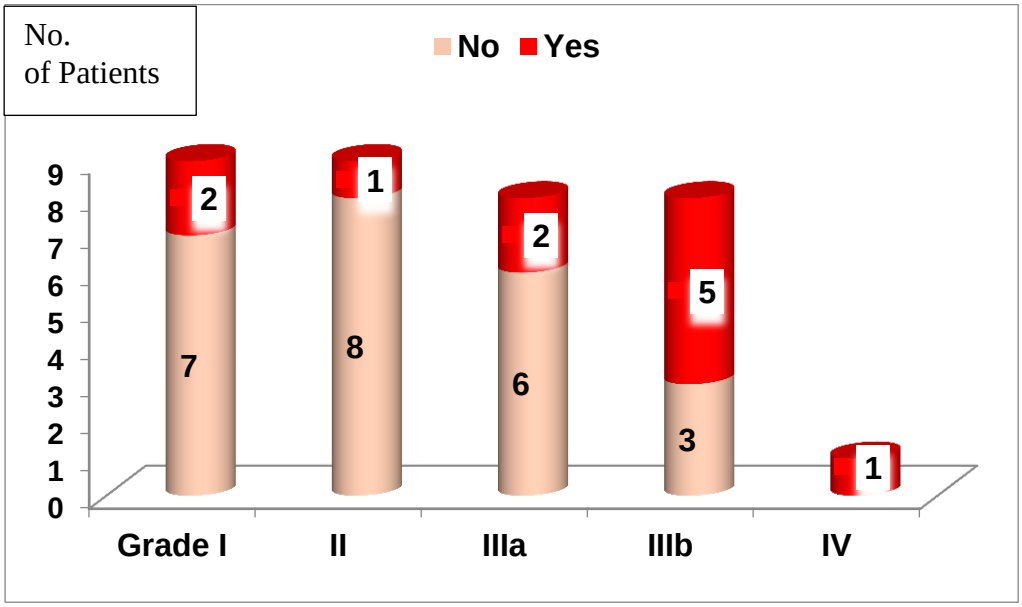
Grades of Emphysematous Pyelonephritis

Irrespective of admission to ward/ICU more than 2/3rd patient does not required oxygen or ionotropic life support for there clinical course in hopsital. We stratified patients with different grades of EPN and need for oxygen or ionotropic life support as shown in table 9,10 graph 8,9 it has been found that maximum number of patients with grade IIIb required oxygen or ionotropic life support (14.3 and 8.6%).

Table no. 9: Frequency and percentages of Subjects on Oxygen support with different grades of EPN

O2 Support		**CT wise Grades of EPN**					
		Grade I	II	IIIa	IIIb	IV	Total
No	No. (n)	7	8	6	3	0	24
	Percentage	20.0%	22.9%	17.1%	8.6%	0.0%	68.6%
Yes	No. (n)	2	1	2	5	1	11
	Percentage	5.7%	2.9%	5.7%	14.3%	2.9%	31.4%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 7.99 df = 4; p = 0.09 (Not significant)							

Graph no.8: Number of Patients on Oxygen support with different grades of EPN

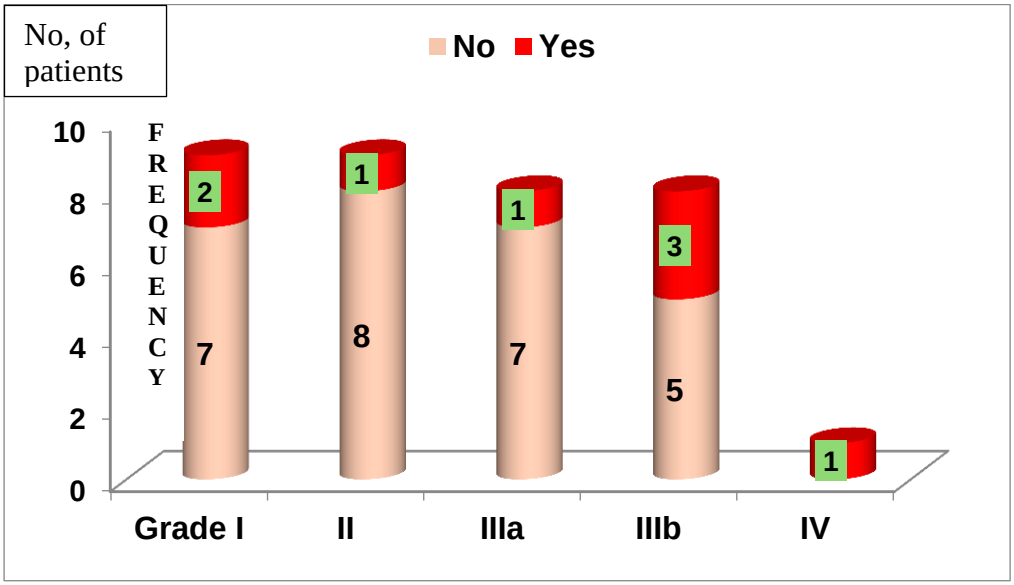


Grades of Emphysematous Pyelonephritis

Table no. 10: Number and percentages of Subjects on Ionotropes in subjects with different grades of EPN

Iono- tropes		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	No. (n)	7	8	7	5	0	27
	Percentage	20.0%	22.9%	20.0%	14.3%	0.0%	77.1%
Yes	No. (n)	2	1	1	3	1	8
	Percentage	5.7%	2.9%	2.9%	8.6%	2.9%	22.9%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 5.54 df = 4; p = 0.23 (Not significant)							

Graph no. 9: Number of Subjects on Ionotropes in subjects with different grades of EPN



Grades of Emphysematous Pyelonephritis

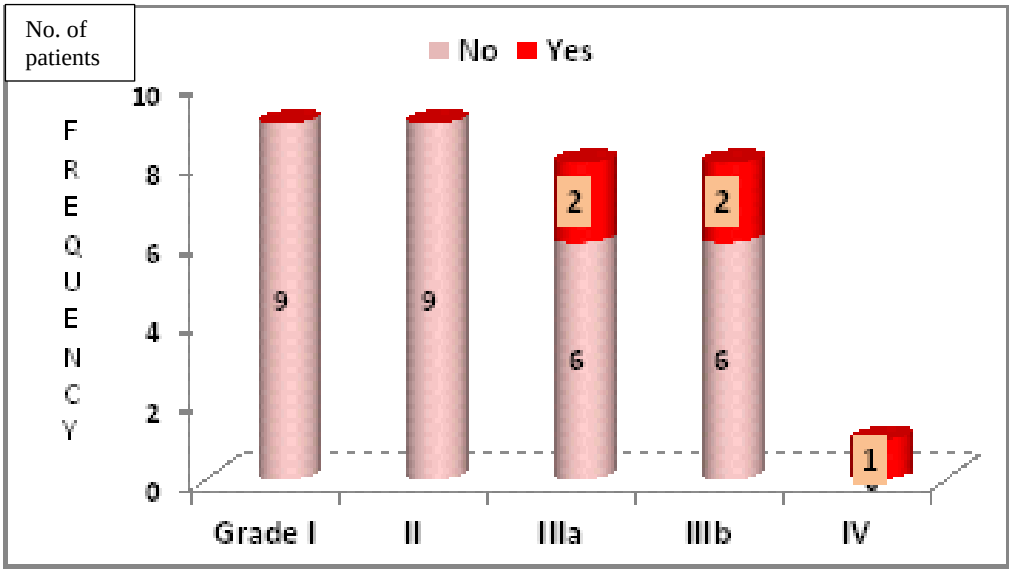
Patient requiring dialysis are those with altered renal or blood parameters or those who are on dialysis due to known CKD. Out of total patients in present 14.3 % (5/35) required dialysis at presentation for optimisation of vitals and blood parameters.

Grades 1 and 2 does not required dialysis in present study whereas grade 3 and 4 required dialysis at presentation. Table no 11 and graph 10 shows Number and percentages of patients on Dialysis in subjects with different grades of EPN

Table no. 11: Number and percentages of patients on Dialysis in subjects with different grades of EPN

Dialysis		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	No. (n)	9	9	6	6	0	30
	Percentage	25.7%	25.7%	17.1%	17.1%	0.0%	85.7%
Yes	No. (n)	0	0	2	2	1	5
	Percentage	0.0%	0.0%	5.7%	5.7%	2.9%	14.3%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 10.5 df = 4; p = 0.03 (Significant)							

Graph no. 10: Number of patients on Dialysis in subjects with different grades of EPN



Grades of Emphysematous Pyelonephritis

E. HEMATOLOGICAL INVESTIGATION

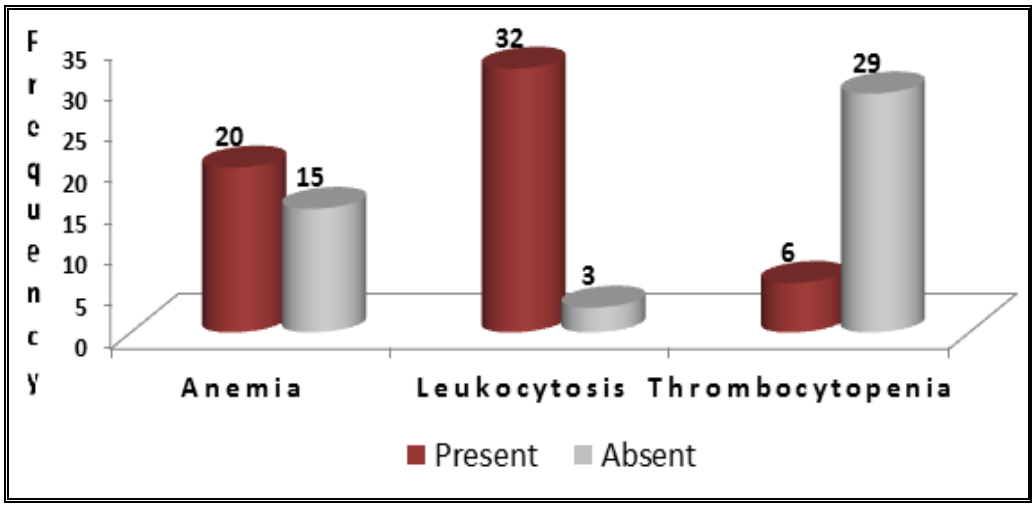
Routine investigation like hemogram, renal function test, liver function test, inflammatory markers like c reactive protein and procalcitonin level were sent in all patients with EPN.

As shown in Table no. 12, Graph no 11, out of 35 subjects, 20 (57%) had Anaemia; 32 (91%) had leucocytosis and 6 (17%) had Thrombocytopenia, thereby suggesting Anaemia and Leucocytosis as more probabilistic relevance with EPN.

Table No. 12: Hemogram Findings in study subjects having EPN

N = 35	**Present**	**Absent**	**Total**
	n (%)	n (%)	
Anemia	20 (57)	15 (43)	35
Leukocytosis	32 (91)	3 (9)	35
Thrombocytopenia	6 (17)	29 (83)	35
Total	58	47	105

Graph No. 11: Frequency of Hemogram Findings in study subjects having EPN



As shown in table no. 13, Deranged S. Creatinine is observed in 60 % of EPN patients. Deranged Blood urea and S. Electrolytes are seen only 49 and 29% of EPN patients.

Correlation between S. Creatinine levels and Blood urea is significant ($r = 0.79$, $p = 0.001$); and between deranged s. Creatinine and deranged electrolytes is significant at modest level ($r = 0.51$; $p = 0.01$).

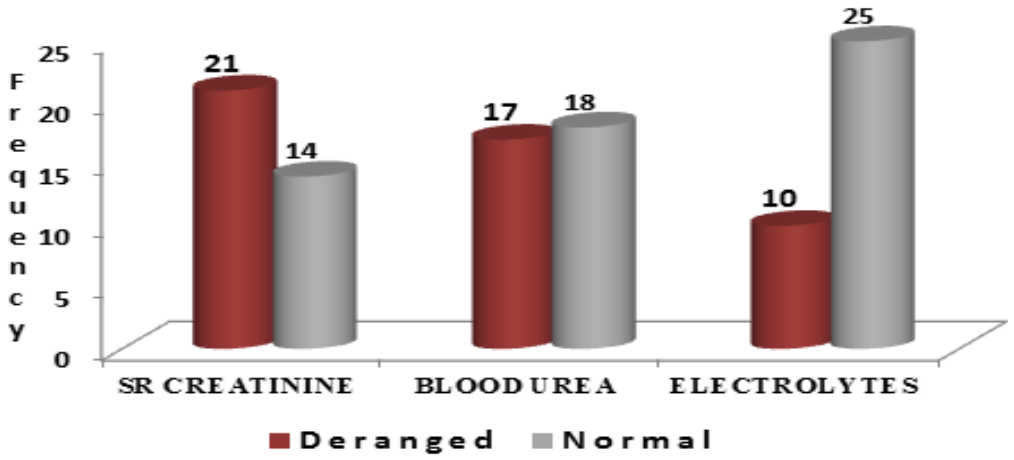
Table No. 13a: Renal Function Parameters in study subjects having EPN

N = 35	Deranged	Normal	Total
	n (%)	**n** (%)	
S. Creatinine	21(60)	14 (40)	35
Blood Urea	17 (49)	18 (51)	35
S. Electrolytes	10{29)	25 (71)	35
Total	48	57	105

Table No. 13b: Correlation between Deranged S. Creatinine & Deranged Blood urea

Correlation	Kendall's tau	Spearman's rho
Correlation coefficient between Deranged S. Creatinine & Deranged Blood urea.	r 0.79; p = 0.001 (2 tailed)	r = 0.79; p = 0.001 (2 tailed)
Correlation coefficient between Deranged S. Creatinine & Deranged Electrolytes	r = 0.51; p = 0.03 (2 tailed)	r = 0.51; p = 0.01 (2 tailed)
Correlation coefficient between Deranged Blood urea & Deranged Electrolytes	r = 0.39; p = 0.2 (2 tailed)	r = 0.39; p = 0.18 (2 tailed)

Graph no. 12: Frequency of Renal Function Parameters in EPN



F. URINE EXAMINATION

Urine routine microscopy and culture was sent in all patients with EPN findings were noted. Table no. 14 shows on microscopic examination urine; (80+11) Ninety one per cent of patients had pus cells; while eleven per cent (11%) had RBC in urine. Only one patient demonstrated Fungus mycelia in urine. Similarly Urine Culture was positive in Eighty three per cent patients. Most common grown organisms were E coli in Fifty one and Klebsiella in Seventeen per cent of patients. The percentage of urine culture positive rates with different grades of EPN, I, II, IIIa, IIIb were 23, 20, 20, 20 per cent respectively as displayed in Table no. 15. Blood culture done in all 35 patients turned out to be positive in only twenty per cent of patients as shown in table no. 16

Table no. 14: Frequency of Urine Microscopic Examination and Culture Findings in study subjects having EPN

Microscopic Examination	**n** (%)
Pus Cells	28 (80)
RBC & Pus Cells	4 (11)
Fungus	1(3)
Normal	2 (6)
Total	35
Urine Culture Findings	
E. Coli	18 (51)
Klebsiella	6 (17)
Pseudomonas Aeruginosa	2 (6)
Pseudomonas Luteola	1 (3)
Proteus Mirabilis	1 (3)
Enterococcus Faecium	1 (3)
No Gowth	6 (17)
Total	35

Table No. 15: Showing urine culture growth in various grades of EPN

EPN GRADES	URINE CULTURE GROWTH		TOTAL
	POSITIVE	STERILE	
	n (%)	n (%)	n (%)
I	8 (23%)	1 (3%)	9 (26%)
II	7 (20%)	2 (6%)	9 (26%)
IIIa	7 (20%)	1 (3%)	8 (23%)
IIIb	7 (20%)	1 (3%)	8 (23%)
IV	0	1 (3%)	1 (2%)
Total	29 (83%)	6 (17%)	35 (100%)
Pearson Chi-Square = 5.47; df = 4 ; p = 0.24 (Not significant)			

Table no. 16a: Organisms grown on Blood culture

Blood culture Organisms grown	n (%)
E. Coli	6 (17)
Enterococcus Faecium	1 (3)
No Growth	28 (80)
Total	35 (100)

Table No. 16b: Frequency of Blood Culture Findings in different grades of EPN

Blood culture	Grades of EPN					Total
	I	II	IIIa	IIIb	IV	
Positive	1	3	1	2	0	7
Negative	8	6	7	6	1	28
Total	9	9	8	8	1	35
Chi sq. = 2.1; df = 4 , p = 0.71 (Not significant)						

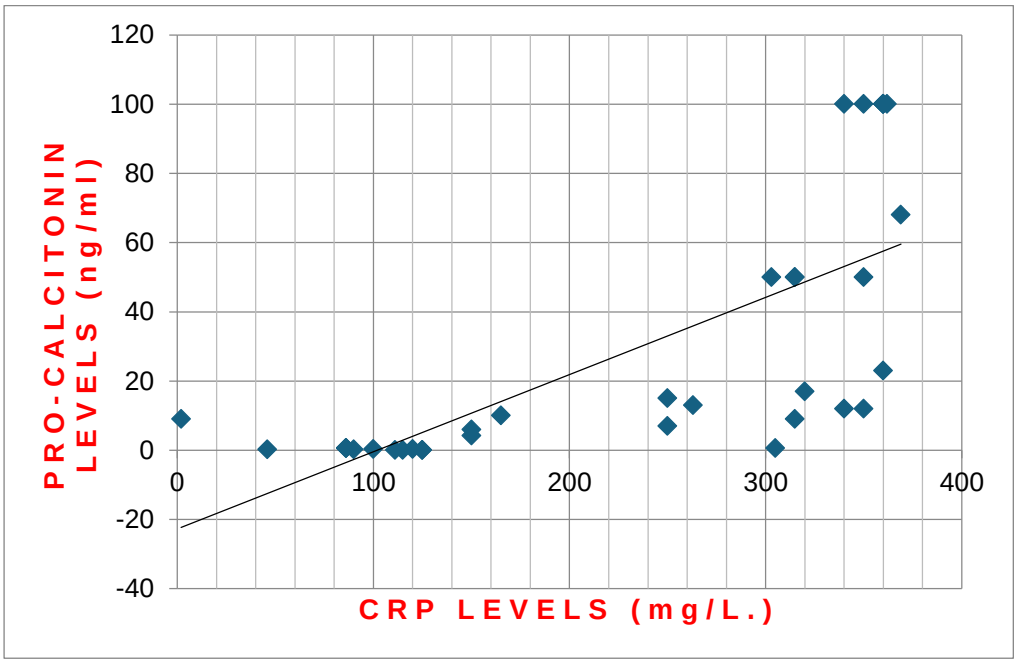
G. CRP (c reactive protein) & PCT (PROCALCITONIN)

Study of CRP and Procalcitonin in present study reveals mean value of 231.26 and 28.82 respectively and correlation coefficient r between them is 0.7; p = 0.001 (Table no. 17).

Table No. 17: Acute phase reactants (C-Reactive Protein (CRP) & Procalcitonin- (PCT)

	Mean	Std. Deviation	N	Correlation	p (2 tailed)
CRP	231.26	118.498	35	r =0.7	p< 0.001
PCT	28.82	37.33907	35		

Graph No. 13: Scatter graph showing relation between CRP and Pro-calcitonin levels in blood



Importance of quantitative level of CRP in Blood culture positive and Negative patients was studied. Blood culture positive patients had higher mean CRP of 315 ± 75.4 as compared to that of 210 ± 11 in Blood Culture negative patients; t = 2.89, p = 0.01 (Table no. 18). However PCT has not shown statistically significant similar relation.

Table 18: Relation between Blood Culture Growth vs Mean quantitative CRP and Mean Serum Procalcitonin (PCT) levels in study subjects having EPN

Blood culture Growth		**CRP**	
		Mean ± SD	Student unpaired 't' test; and p value
	Positive (n = 7)	315 ± 75.4	2.89, p= 0.01
	Negative (n = 28)	210 ± 118.8	
Blood culture Growth		**S. Procalcitonin (PCT)**	
		S. Procalcitonin (PCT)	Student unpaired 't' test; and p value
	Positive (n = 7)	50.45 ± 46.7	1.44, p = 0.19
	Negative (n = 28)	23.42 ± 33.4	

Table no. 19: Descriptive statistics of CRP and PCT in different grades of EPN

EPN GRADES	CRP					
	n	Mean	Median	SD	IQR	Std. Error
I	9	199	165	145.18	282	48.39
II	9	227.22	263	115.51	229.5	38.5
IIIa	8	312.12	312.5	45	91.8	15.93
IIIb	8	205.75	137	123.79	248.8	43.76
IV	1	115	-	-	-	-
EPN GRADES	Procalcitonin (PCT)					
	n	Mean	Median	SD	IQR	Std. Error
I	9	25.72	10	34.21	49.8	11.4
II	9	22.3	9	33.2	35.9	11.06
IIIa	8	33.7	16	35.3	55.3	12.49
IIIb	8	38.38	3.31	51.06	99.9	18.05
IV	1	0.06	-	-	-	-

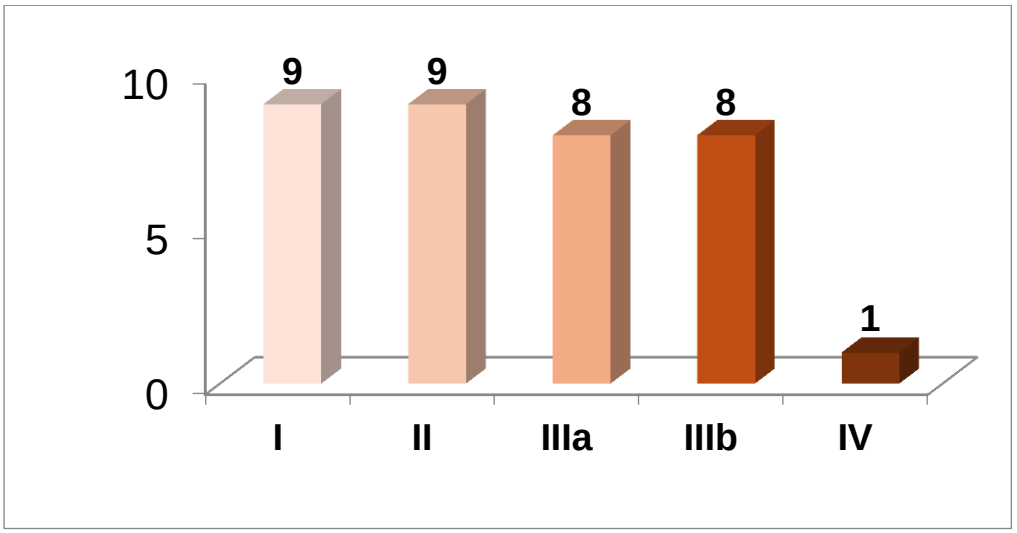
H. IMAGING INVESTIGATION

All patients with EPN underwent NCCT KUB having suspicious diagnosis of EPN on USG or Xray. NCCT KUB without contrast was done in all patients as this avoids risk of contrast allergy in already ill patients and it saves the time to arrive at early diagnosis and classify EPN into different grades.

- **GRADING OF EPN :** Grading of EPN was done by NCCT KUB study; almost equal no patients were in group I to Group IIIb as shown in table no 20. and Graph no 14. Only one patient was having Grade IV EPN.

Table no. 20: Frequency and Percentages of Grades of EPN

Grades of EPN	n (%)
I	9 (26)
II	9 (26)
IIIa	8 (23)
IIIb	8 (23)
IV	1 (2)
Total	35 (100%)



Grades of Emphysematous Pyelonephritis

- **NCCT KUB FINDINGS:** All patients suspicious of gas on USG abdomen underwent Non contrast CT scan of KUB region for confirmation of diagnosis of EPN. Table 20a showing different CT findings in patients with EPN.

EPN was observed in 21/35 (60%), and 14 /35 (40%) of patients in Left, and Right Kidneys respectively. The data suggest involvement of Left kidneys is almost 1.5 times that of Right Kidneys

Table 20a: Frequency and Percentages of NCCT KUB Findings

Sr. No.	NCCT KUB Findings	n	%
1	Bilateral ADPKD with left EPN	1	2.9
2	Left bulky kidney with EPN and perinephric stranding	4	11.4
3	Left bulky kidney with multiloculated cyst with air foci and abscess	2	5.7
4	Left EPN	4	11.4
5	Left EPN with left puj calculus of size 13*7 mm	1	2.9
6	Left EPN with mid ureteric calculus	1	2.9
7	Left EPN with perinephric and retroperitoneal collection	2	5.7
8	Left EPN with upper ureteric calculus	4	11.4
9	left EPN with ureteric calculus	1	2.9
10	Left pyonephrotic kidney with EPN	1	2.9
11	Right empysematous pyelonephritis with perinephric collection 14*17 cm with pyonephrosis	1	2.9
12	Right EPN	2	5.7
13	Right EPN with pyonephrosis	1	2.9
14	Right EPN with perinephric collection with pyonephrosis	1	2.9
15	Right EPN with perinephric stranding	1	2.9
16	Right EPN with perinepric collection with hun	2	5.7
17	Right renal pelvic calculus with EPN	1	2.9
18	Right side EPN with distal ureteric calculus 11.9 mm	1	2.9
19	Right side EPN with hun	1	2.9
20	Right side EPN with mild hun	2	5.7
21	Right side EPN with mild pcs fullness	1	2.9
	Total	35	100

From the NCCT KUB finding it has been found that EPN patient found with calculus disease in 1/4th of patients. In the present study EPN was most commonly associated with upper ureteric calculus.

Table 20b: Frequency and Percentages of stone disease in EPN

Site of Calculus	No of patients	Percentage (%)
Pelvic calculus	2	5.7
Upper ureteric calculus	4	11.4
Mid ureteric calculus	1	2.9
Distal ureteric calculus	2	5.7
Total	9	25.71

I. MANAGEMENT

Patients with EPN were initiated on broad-spectrum antibiotics in accordance with the hospital's antibiotic policy. Upon admission, urine and blood cultures were collected, and the antibiotic regimen was adjusted or escalated based on the clinical response and the results of the culture reports.

Patients were monitored for symptoms vital and blood parameter serially and managed with minimally invasive treatment options like PCN/DJ stenting (drainage of pelvicalyceal system) or PCD (drainage other than pelvicalyceal system) based on the grade of EPN on NCCT KUB and clinical response to parenteral antibiotics.

Minimally invasive treatment broadly classified into external drainage defined as drainage of pelvicalyceal system (PCN) and other than pelvicalyceal system (PCD) through malecot catheter.

Out of 35 patient external drainage required in 23 patients. PCN was done in 13 (37.14%), PCD done in 3 patients (8.5%) for drainage of perinephric collection like air or pus. 7 patients required drainage by both PCN and PCD.

Table no. 21: Distribution of patients with minimally invasive treatment and nephrectomy

<table>
<tr><th>External Drainage
n (%)</th><th>Internal Drainage
n (%)</th><th>External+Internal Drainage
n (%)</th><th>Nephrectomy
n (%)</th></tr>
<tr><td>PCN
13 (37.14)</td><td>DJ STENTING
19 (54.28)</td><td>PCN+DJ STENTING
6 (17.14)</td><td>Yes
7 (20)</td></tr>
<tr><td>PCD
3 (8.5)</td><td rowspan="3">NO
16 (45.71)</td><td>PCN+PCD+DJ STENTING
3 (8.57)</td><td rowspan="3">No
28 (80)</td></tr>
<tr><td>PCN+PCD
7(20)</td><td rowspan="2">NO
26 (74.28)</td></tr>
<tr><td>NO
12 (34.28)</td></tr>
<tr><td>TOTAL
35 (100%)</td><td>35 (100%)</td><td>35 (100%)</td><td>35 (100%)</td></tr>
</table>

Internal drainage of the pelvicalyceal system done by DJ stenting under anaesthesia in surgically fit patients to avoid cumbersome external catheter (PCN/PCD). DJ stenting was done in almost half (54.28%) of the patients in present study.

Instead of drainage in the form of external or internal 7 patients (20%) did not responded to minimally invasive treatment required nephrectomy. Distribution of various treatment options described in table no 21.

Those patient who need nephrectomy were further studied and found that there were 3 patients in which despite drainage with PCN and PCD there was no improvement in clinical condition and ultimately required nephrectomy table 21a showing distribution of patients managed with external or internal drainage requiring nephrectomy. Distribution of patients requiring nephrectomy according to grading of EPN shown in table 22b.

Table 22 a: Distribution of patients requiring Nephrectomy

DRAINAGE	**N=7**	**%**
PCN+PCD	3	42.85
PCN	1	14.28
PCD	1	14.28
PCN+PCD+DJ STENTING	1	14.28
DJ STENTING	0	0
NONE	1	14.28
TOTAL	7	100

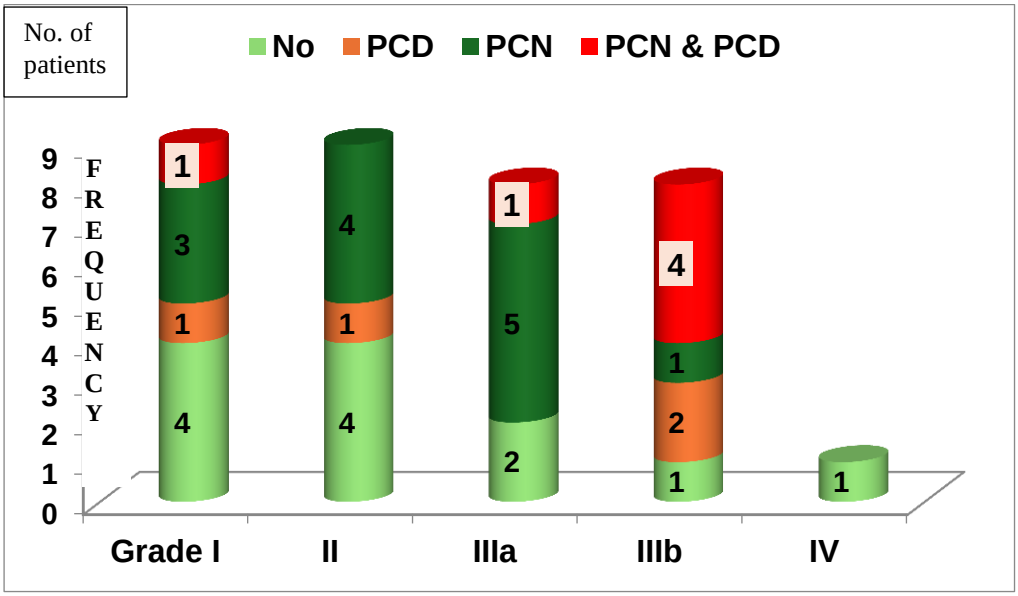
Table no. 22b: Number and percentages of Subjects underwent surgical intervention with different grades of EPN

Surgical intervention		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	No. (n)	7	4	7	4	0	22
	Percentage	20.0%	11.4%	20.0%	11.4%	0.0%	62.9%
Nephrectomy	No. (n)	1	2	0	3	1	7
	Percentage	2.9%	5.7%	0.0%	8.6%	2.9%	20.0%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 15.84 df =12; p = 0.19 (Not Significant)							

Table no. 23: Number and percentages of Subjects on PCN & PCD with different grades of EPN

PCN & PCD		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	No. (n)	4	4	2	1	1	12
	Percentage	11.4%	11.4%	5.7%	2.9%	2.9%	34.3%
PCD	No. (n)	1	1	0	2	0	4
	Percentage	2.9%	2.9%	0.0%	5.7%	0.0%	11.4%
PCN	No. (n)	3	4	5	1	0	13
	Percentage	8.6%	11.4%	14.3%	2.9%	0.0%	37.1%
PCN & PCD	No. (n)	1	0	1	4	0	6
	Percentage	2.9%	0.0%	2.9%	11.4%	0.0%	17.1%
Total	No. (n)	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 15.7 df = 12; p = 0.2 (Not significant)							

Graph no. 15: Number of Subjects on PCN & PCD with different grades of EPN

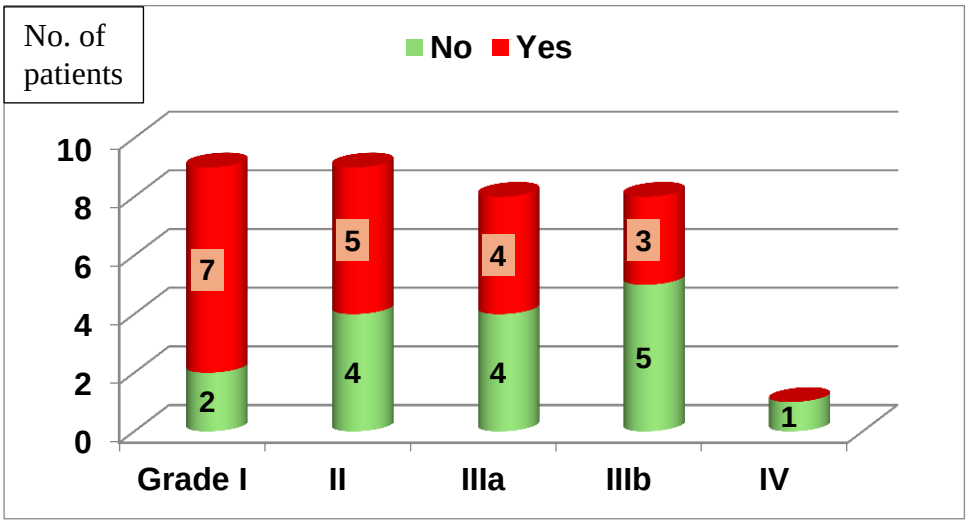


Grades of Emphysematous Pyelonephritis

Table no. 24: Number and percentages of Subjects on DJ stent with different grades of EPN

DJ stent		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	**No. (n)**	2	4	4	5	1	16
	Percentage	5.7%	11.4%	11.4%	14.3%	2.9%	45.7%
Yes	**No. (n)**	7	5	4	3	0	19
	Percentage	20.0%	14.3%	11.4%	8.6%	0.0%	54.3%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 4.16; df = 4; p = 0.38 (Not significant)							

Graph no. 16: Number of Subjects on DJ with different grades of EPN



Grades of Emphysematous Pyelonephritis

J. OUTCOME

After minimally invasive treatment patients showing signs of recovery were discharged without any tube (no internal or external drainage) or discharged with tube (DJ stent or PCN/PCD). Maximum number of patients (48.6%) discharged with DJ stent in situ to avoid cumbersome handling and care of catheter/tube. Table no 25 showing grade wise distribution of patients discharged from hospital.

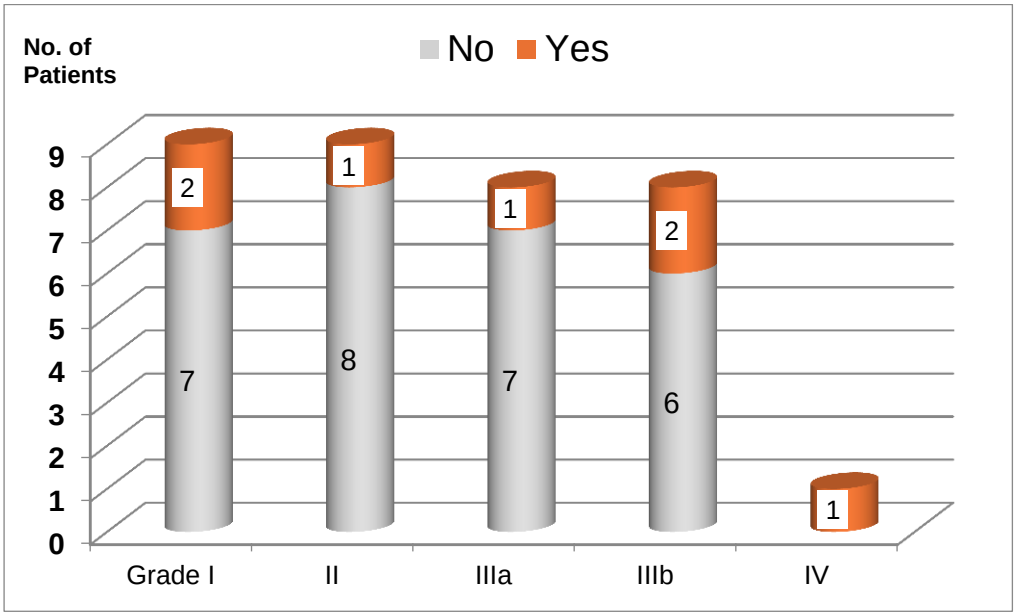
Table no. 25: Showing EPN grades vs outcome (improved /discharged)

OUTCOME		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
DISCHARGED	**No. (n)**	2	4	0	2	1	9
	Percentage	5.7%	11.4%	0.0%	5.7%	2.9%	25.7%
DISCHARGED WITH DJ STENT	**No. (n)**	6	3	6	2	0	17
	Percentage	17.1%	8.6%	17.1%	5.7%	0.0%	48.6%
DISCHARGED WITH PCD	**No. (n)**	0	0	0	1	0	1
	Percentage	0.0%	0.0%	0.0%	2.9%	0.0%	2.9%
DISCHARGED WITH PCN	**No. (n)**	1	2	2	0	0	5
	Percentage	2.9%	5.7%	5.7%	0.0%	0.0%	14.3%
NO	**No. (n)**	0	0	0	3	0	3
	Percentage	0.0%	0.0%	0.0%	8.6%	0.0%	8.6%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 24.95; df = 16 ; p = 0.07 (Not significant)							

Table no. 26: EPN Grades Vs Deteriorated (NO / YES)

DETIRIORATED		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
NO	**No. (n)**	7	8	7	6	0	28
	Percentage	20.0%	22.9%	20.0%	17.1%	0.0%	80.0%
YES	**No. (n)**	2	1	1	2	1	7
	Percentage	5.7%	2.9%	2.9%	5.7%	2.9%	20.0%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 4.87 ; df = 4; p = 0.3 (Not significant)							

Graph no. 17: EPN Grades VS Detiriorated (No / Yes) On Follow Up



Grades of Emphysematous Pyelonephritis

Patients are followed during the hospital course after giving required treatments 80% of patients improved and discharged from the hospital. Those patients who shows signs of deterioration despite minimally invasive treatments required further surgical intervention.

Table no. 27: EPN Grades VS Re-Intervention

REINTERVENTION		**CT wise Grades of EPN**					
		Grade I	II	IIIa	IIIb	IV	Total
EXPLORATORY LAPAROTOMY WITH DECOMPRESSION OF BOWEL	**No. (n)**	0	0	0	0	1	1
	Percentage	0.0%	0.0%	0.0%	0.0%	2.9%	2.9%
NEPHRECTOMY	**No. (n)**	1	2	0	3	0	6
	Percentage	2.9%	5.7%	0.0%	8.6%	0.0%	17.1%
NO	**No. (n)**	7	7	7	5	0	26
	Percentage	20.0%	20.0%	20.0%	14.3%	0.0%	74.3%
PCN AND PCD	**No. (n)**	1	0	1	0	0	2
	Percentage	2.9%	0.0%	2.9%	0.0%	0.0%	5.7%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 41.04; df = 12 ; p = 0.001 (Significant)							

2 patients required reintervention in the form of PCN and PCD for the residual collection and gas surrounding kidney. One patient with grade IV EPN post nephrectomy developed intestinal obstruction which required exploratory laparotomy with decompression of bowel and ileostomy. Table 27 showing grade wise distribution of patients requiring reintervention.

Despite all efforts 2 patients succumbed irrespective of any form of intervention during hospital course and one patient died in during the follow up admission. All the patients were belonging to grade IIIb of EPN.

Final outcome of the study was resolution of EPN seen in 91.4% of patient and mortality was seen in remaining 8.6% of the patients. (table 29 and 30)

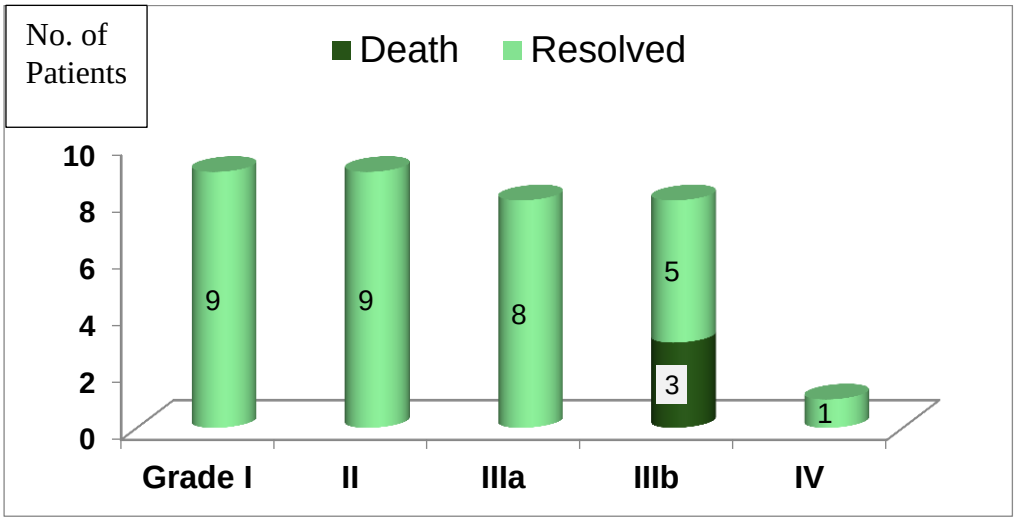
Table no. 28: Showing EPN Grades VS Death

DEATH		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
No	**No. (n)**	9	9	8	6	1	33
	Percentage	25.7%	25.7%	22.9%	17.1%	2.9%	94.3%
Yes	**No. (n)**	0	0	0	2	0	2
	Percentage	0.0%	0.0%	0.0%	5.7%	0.0%	5.7%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 7.15 ; df = 4; p = 0.12 (Not significant)							

Table no. 29: EPN Grades VS Two Months Follow Up Results

FOLLOW UP RESULTS		CT wise Grades of EPN					
		Grade I	II	IIIa	IIIb	IV	Total
DEATH	**No. (n)**	0	0	0	3	0	3
	Percentage	0.0%	0.0%	0.0%	8.6%	0.0%	8.6%
RESOLVED	**No. (n)**	9	9	8	5	1	32
	Percentage	25.7%	25.7%	22.9%	14.3%	2.9%	91.4%
Total	**No. (n)**	9	9	8	8	1	35
	Percentage	25.7%	25.7%	22.9%	22.9%	2.9%	100.0%
Pearson Chi-Square: = 11.07; df = 4; p = 0.02 (Significant)							

Graph no. 18: Follow up evaluation: Death VS Resoled in different grades of EPN



Grades of Emphysematous Pyelonephritis

DISCUSSION

Emphysematous pyelonephritis (EPN) being a devastating necrotizing lesion of infected Renal and Peri-renal tissues; this Feasible, Interesting, Novel, Ethical, and Relevant (FINER) study was planned and conducted at Tertiary care centre of Dayanand Medical College, Ludhiana, Punjab. The main Objective was to unravel and analyse the Demographic, Clinical, Metabolic, intrinsic Uro-sepsis and obstructive uropathy factors promoting EPN. At the same time the main Aim was to evaluate the Specific, Measurable, Achievable Realistic role of conservative vs Surgical (Nephrectomy) approach in preventing subsequent morbidity and mortality in a Time Bound Framework. (SMART).

Total thirty five patients were included prospectively during the study period. The results of the present study were analysed and compared with other studies as shown in table 30.

Table 30. Comparison of present study with published literature

Sr no	Study	Design	Sample	Finding
1	Hunag et al[8]	Prospective	48	Class 1 or 2 & class 3 or 4 with <2 risk factors- conservation Others- nephrectomy
2	Michaeli et al[6]	Retrospective	54	Resuscitation, early antibiotics, relief of obstruction & early nephrectomy.
3	Shokeir et al[12]	Retrospective	20	Nephrectomy
4	Bum Soo Park	Retrospective	17	Conservation in

	Et al[5]			selected cases
5	Chen et al[23]	Retrospective	25	Antibiotics with CT guided drainage
6	Wan et al [19]	Retrospective	38	Predictors of high risk – S.Creatinine & Platelet count
7	Kilpauk Medical College Hospital.	Prospective	40	Minimal invasive surgeries feasible. Predictors of poor outcome identified
8	Rajeshkumar Reddy Adapala[31]	Prospective	36	Renal preserving strategy not only improved the survival but also decreased the need for nephrectomy.
9	Aggarwal, D[33]	Prospective	120	Predictors of mortality and nephrectomy
10	Present study	Prospective	35	Minimally invasive treatment options are effective. Nephrectomy is last resort

a. **Age and gender**

Mean age in the present study is 57 years, mean age for females is 57 year and for male is 56 years. Females are more commonly affected than males showing female preponderance which is comparable to other studies.

This demographic characteristics were comparable with recent studies done by Rajeshkumar Reddy Adapala [31], Aggarwal, D[33] and other studies.[3,5-8,12]

b. **Side of involvement**:

In the present study, left kidney is more commonly affected than right kidney. There was a 1.5 times predominance of left kidney over the right side; and comparable to that reported by other studies. One patient presented with bilateral EPN with ADPKD.

c. **Presenting complaints:**

The predominant mode of presentation in the present study was fever (94%), nausea with or without vomiting (51%), loin pain (49%) and Urinary symptoms in 43% of patients.

This is similar to that reported by other studies.[8,12,31,33]

d. **Duration of symptoms:**

Symptoms were for more than seven days in 45 % of subjects and less than seven days in 55% of subjects. In Chen et al's study [3] it was 18 +/- 8.64 days.

e. **Comorbidities**

Presence of Diabetes mellitus: DM was present in 33/35 (94%) of patients in our study

which correlates well with the studies of Chen et al [3] and in Shokeir et al study was 96% [8,12] . The present study also did not demonstrate significant difference in mean HbA1c levels in different grades of EPN; nor there was any relation of outcome with HbA1c level. Similarly present study revealed Hypertension observed in 24/35 (68%) patients suggesting a cumulative role of DM & HTN in EPN.

f. **Presence of shock**

Shock as determined by Tachycardia in 66% and Hypotension 26 % of the patients was observed in our study. Role of shock in ultimate outcome of the patients did not surface in the current study, as there was good outcome of 32/35 (91 %) survival with conservative approach. In comparison, in Huang[8] et al's study 56% in the poor outcome group and 17% of patients in the good outcome group presented with shock [8].

g. **Altered mental status at presentation**:

In the present study, 8/35 (23%) of the patients presented with altered mental status. In comparison, in Huang[8] et al's study 53% altered mental status [8]. Similarly as per the present study; Oxygen and Ionotropic support was observed in 9/35 (26%) and 8/35 (23%) of EPN patients. All these associations neither support their major role in promoting nor preventing EPN.

h. **Altered renal parameters**:

In the present study, the serum creatinine more than 1.5 mg/dl. and Blood Urea more than 40 mg/dl. were considered as criterion for Deranged renal functions in patients presenting with EPN. Both parameters had high correlation coefficients ($r = 0.79$, $p = 0.001$). However, altered renal parameters did not influence the outcome in these patients.

i. **Urine cultures:**

In the present study, E.coli was grown in 18/35 (51%) of patients and Klebsiella pneumoniae in 6/35 (17%) of patients. In comparison, study of Bum Soo Park et al [5], showed E.coli in 52% and Klebsiella pneumonia in 24%. No growth was observed in present study in 6/35 (17%) as compared to Bum Soo Park et al study, where 24% did not show any growth in the urine[5]. Present study also demonstrated urine culture positive for Pseudomonas Aeruginosa in two and Pseudomonas Luteola in 1 patient; thereby dictating the need for appropriate antibiotics treatment according to urine culture report in these patients.

j. **Blood cultures:**

In the present study, blood cultures were positive in 7/35 (20%) of patients. This compares well with Wan et al's study which 42.10% had positive blood cultures but is much less than in Bum Soo Park et al's study cultures. [5,7]

k. **Management and outcome according to radiological grades of EPN:**

In the present study Management of all these EPN patients were done as per various protocol such as 1) Ward vs ICU, 2) Parenteral Antibiotics 3) Oxygen Support, 4) Ionotropic support 5) Dialysis requirement, 6) PCN/PCD or both use, 7) DJ stent , 8) and Surgical i.e. Nephrectomy. Observations and results are shown in Table no 19, 19a; No statistical significant difference was observed; However from Grade IIIb, two patients died during hospitalization and one on follow up of two months. The outcome was 28 out of 35 patients (80%) achieved success with minimally invasive treatment of EPN, regardless of grade. This success rate is comparable to that reported in the study by Huang et al.[8]

l. Management and outcome:

In the present study, Antibiotics were used in all thirty five patients; as evidenced by Pyuria in 28/35 (80%) (vide table no. 8); various bacterial growth in urine culture in 29/35(83%) (vide table no 9); Serum CRP level more than 46 mg/l in 34/35 (97%); and Significant S. Procalcitonin level (> 4.2 ng/ml) in 23/35 (66%) of EPN, and Blood culture growth in 7/35 (20%) patients. As the requirement for subsequent Nephrectomy was low 20%; and ultimate mortality in 3/35 (14%). Early and appropriate antibiotic use has a significant salvaging effect for minimally invasive therapy in patients with EPN. Similar observations were made by Huang et al[8]. With advancements in antibiotic therapy and minimally invasive treatment options, focus has shifted to the control of sepsis by means of broad-spectrum antibiotics and drainage of EPN kidney. Minimally invasive treatment option includes external drainage in the form of PCN and or PCD was required in 23 (65.72%) patients, internal drainage in the form of DJ stenting under anaesthesia

required in 19 (54.28%) patients and 5(14.28%) patients required both external as well as internal drainage (PCN+/-PCD with DJ stent) along with parenteral antibiotic coverage. In the present study 80 % of patients managed with minimally invasive treatment and 20 % required removal of EPN kidney i.e. nephrectomy irrespective of drainage of EPN kidney. According to studies done by *Somani BK*[34] *and Aboumarzouk OM*[35] Renal salvage approaches such as drainage along with parenteral antibiotic coverage have emerged as first-line therapeutic strategies. In 1986, Hudson *et al*.[9] first reported a case of EPN treated successfully with fluoroscopically guided percutaneous drainage. Since then, various authors have described successful results with percutaneous drainage.[34,36-38]

Early recognition of the condition, prompt resuscitation, adequate drainage of gas as well as infected fluid and effectively relieving the urinary tract obstruction reduced mortality rate to 8.6 % in our study. The mortality rate in patients with EPN was 78% until the late 1970s.[7,39] The improvements in imaging modalities for detection of EPN in early stages, availability of good parenteral antibiotics, multidisciplinary approach of managing sepsis-related complications, and a paradigm shift toward preference for minimally invasive drainage procedures resulted in reduced mortality rate to 21%.[34,39]

Besides, the striking overall survival rate (91.4%), we also found decreased need for nephrectomy. Salvage nephrectomy was performed in seven patients (20%) in our study due to ongoing sepsis in spite of initial minimally invasive treatment measures. In a systematic review by Somani *et al*.,[34] including ten retrospective studies on 210 patients with EPN, the reported mortality from Medical Management (MM) alone was 50%, MM combined with EN (early nephrectomy) was 25%, and MM combined with percutaneous drainage was 13.5%. Hence it is recommended that percutaneous drainage should be part of initial treatment strategy for EPN.

SUMMARY AND CONCLUSIONS

In the study involving 35 patients, the following observations were made:

1) Emphysematous pyelonephritis (EPN) occurs more frequently in females.

2) There is a slight preference for the left kidney over the right.

3) The primary symptoms at presentation are fever and loin pain.

4) Individuals with diabetes are predominantly affected by EPN.

5) Patients may present with symptoms that are not directly related to EPN.

6) Although ultrasound and X-ray KUB are useful, non-contrast CT KUB is the most
reliable diagnostic tool.

7) Positive urine cultures are common, with E. coli being the predominant pathogen.

8) When blood cultures are positive, the same organisms are typically found in the urine
cultures.

9) Managing underlying urinary tract obstruction helps in preserving renal function.

10) A combination of treatments, including antibiotics, percutaneous nephrostomy (PCN)
with or without percutaneous catheter drainage (PCD), and DJ stenting, can achieve
renal preservation in 80% of cases. Resolution of EPN after follow up of 2 months
was 91.4%

CONCLUSIONS

A renal salvage protocol that includes aggressive resuscitation, intravenous antibiotic therapy, early drainage of infected fluid and gas, and prompt relief of urinary tract obstruction is an effective approach for the initial management of emphysematous pyelonephritis (EPN). This strategy not only enhances survival rates but also aids in preserving renal function. Based on our study, we propose the following recommendations:

1. The primary aim in managing EPN should be to preserve renal function to the greatest extent and minimal morbidity. This should be achieved through early renal preservation measures like minimally invasive treatment modalities, regardless of the disease stage or presence of high-risk prognostic factors.
2. Efforts should be made to identify any urinary tract obstruction, and if present, it should be addressed promptly.
3. Renal salvage necessitates a multidisciplinary approach, starting with comprehensive medical management and followed by carefully chosen, stepwise minimally invasive treatment. This has been shown to enhance patient outcomes and decrease the traditional morbidity linked with nephrectomy.
4. Salvage nephrectomy should be reserved for patients with progressive disease and persistent sepsis despite initial minimally invasive treatment.

LIMITATIONS OF STUDY

1. Time bound study with rare complications of a common disease led us to sample size limitation of 35 cases only
2. Post discharge follow up for two months; did not reveal long term [more than a year] complications rate or eventualities.
3. Role of BMI, as comorbidity was not studied
4. eGFR was not studied on admission or follow up
5. Fundus exam by ophthalmologist was not studied which could have revealed the indirect evidence of Renal vasculopathy.

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SR NO	MRD	INITIALS	AGE	GENDER	PRESENTING COMPLAINTS					DURATION OF SYMPTOMS		CO-MORBIDITIES				
					FEVER	FLANK PAIN	NAUSEA/ VOMITING	URINARY SYMPTOMS	ANY OTHER SYMPTOMS	<7 DAYS	>7 DAYS	DM	HTN	THYROID DISEASES	CAD	CKD
1	1377530	MR	56	F	YES	YES	YES	NO	NO	NO	YES	YES	YES	NO	NO	NO
2	1400002	MK	60	F	YES	NO	YES	YES	WEAKNESS, ANOREXIA	YES	NO	YES	YES	YES	NO	MO
3	1487831	NB	56	F	YES	YES	YES	NO	NO	YES	NO	YES	NO	NO	NO	NO
4	1362271	AK	63	F	YES	YES	YES	NO	WEIGHT LOSS	YES	NO	YES	YES	YES	NO	NO
5	1336989	Y	60	M	YES	NO	YES	YES	ANOREXIA	NO	YES	YES	YES	NO	NO	YES
6	1014874	VK	58	F	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	YED	NO
7	1498553	BS	55	M	YES	YES	NO	NO	no	YES	NO	YES	NO	NO	YES	NO
8	1512658	SK	62	M	YES	YES	YES	NO	H/O UROSEPSIS	YES	NO	YES	NO	NO	NO	NO
9	1420205	A	54	F	YES	YES	YES	YES	H/O UROSEPSIS	NO	YES	YES	YES	NO	NO	YES
10	1195903	MB	61	F	YES	YES	YES	NO	NO	NO	YES	YES	YES	NO	NO	YES
11	1508670	GS	52	M	YES	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO	NO
12	1535989	RG	49	F	YES	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
13	1525205	SB	55	F	NO	YES	NO	NO	WEAKNESS, ANOREXIA	NO	YES	YES	YES	NO	NO	NO
14	1462681	AK	66	F	YES	NO	YES	YES	WEAKNESS, ANOREXIA	NO	YES	YES	YES	NO	YES	NO
15	1466895	VK	63	F	YES	NO	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO
16	1597048	BK	54	F	YES	NO	NO	YES	NO	YES	NO	YES	YES	NO	YES	NO
17	1572296	KK	69	F	YES	NO	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES
18	1547311	HK	70	F	YES	NO	YES	NO	WEAKNESS, ANOREXIA	NO	YES	YES	YES	NO	YES	YES

SR NO	MRD	INITIALS	VITALS					HEMOGRAM			RENAL FUNCTION TEST			HBA1C
			LEVEL OF CONCIOUSNESS	TACHYCARDIA >100/MIN YES/NO	HYPOTENSION <100/60MMHG YES/NO	SPO2 (OXYGEN REQUIREMENT) YES/NO	NEED OF IONOTROPICS	ANEMIA	LEUCOCYTOSIS	THROMBOCYTOPENIA	SR CREATININE	BLOOD UREA	ELECTROLYTES	
1	1377530	MR	CONCIOUS	NO	NO	NO	NO	YES	YES	NO	NORMAL	NORMAL	NORMAL	10
2	1400002	MK	CONCIOUS	YES	NO	NO	NO	YES	YES	YES	DERRANGED	NORMAL	DERRANGED	8
3	1487831	NB	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	DERRANGED	9
4	1362271	AK	DROWSY	YES	YES	YES	YES	YES	YES	YES	DERRANGED	DERRANGED	NORMAL	12
5	1336989	Y	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	NORMAL	8.5
6	1014874	VK	DROWSY	YES	YES	YES	YES	YES	YES	NO	NORMAL	NORMAL	NORMAL	10
7	1498553	BS	CONCIOUS	NO	NO	NO	NO	NO	NO	NO	DERRANGED	NORMAL	NORMAL	11
8	1512658	SK	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	DERRANGED	DERRANGED	NORMAL	12
9	1420205	A	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	DERRANGED	8.6
10	1195903	MB	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	NORMAL	NORMAL	NORMAL	7.9
11	1508670	GS	CONCIOUS	YES	NO	NO	NO	NO	YES	NO	DERRANGED	DERRANGED	NORMAL	6.9
12	1535989	RG	CONCIOUS	NO	NO	NO	NO	YES	YES	NO	NORMAL	NORMAL	NORMAL	12.6
13	1525205	SB	CONCIOUS	YES	NO	NO	NO	NO	YES	NO	DERRANGED	DERRANGED	NORMAL	10.2
14	1462681	AK	DROWSY	YES	YES	YES	YES	YES	YES	YES	DERRANGED	DERRANGED	DERRANGED	14
15	1466895	VK	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	NORMAL	NORMAL	NORMAL	9.6
16	1597048	BK	DROWSY	YES	YES	YES	YES	YES	YES	YES	DERRANGED	DERRANGED	DERRANGED	6.9
17	1572296	KK	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	NORMAL	9.3
18	1547311	HK	DROWSY	YES	YES	YES	YES	YES	YES	YES	DERRANGED	DERRANGED	DERRANGED	14

SR NO	MRD	INITIALS	INVESTIGATIONS												
			URINE R/E	URINE CULTURE		BLOOD CULTURE		CRP-Q	PCT	IMAGING					
				NO GROWTH	ORGANISM ISOLATED	NO GROWTH	ORGANISM ISOLATED			USG	CT GRADING OF EPN	NCCT KUB ON PRESENTATION	OTHER	WARD /ICU	ANTIBIOTICS
1	1377530	MR	PUS CELLS	POSITIVE	KLEBSIELLA	STERILE	NO GROWTH	100	0.32	LEFT PYELONEPHRITIS	IIIB	LEFT EPN WITH PERINEPHRIC AND RETROPERITONEAL COLLECTION	N/A	WARD	YES
2	1400002	MK	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	250	7	BULKY LEFY KIDNEY WITH HUN AND PERINEPHRIC STRANDING	IIIA	LEFT BULKY KIDNEY WITH EPN AND PERINEPHRIC STRANDING	N/A	WARD	YES
3	1487831	NB	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	125	0.05	EVOVING LEFT RENAL ABSCESS	IIIB	LEFT BULKY KIDNEY WITH MULTILOCULATED CYST WITH AIR FOCI AND ABSCESS	N/A	WARD	YES
4	1362271	AK	FULL FIELD PUS	POSITIVE	E COLI	STERILE	NO GROWTH	350	12	RIGHT EPN	I	RIGHT SIDE EPN WITH MILD HUN	N/A	WARD	YES
5	1336989	Y	PUS CELLS	POSITIVE	KLBSIELLA	STERILE	NO GROWTH	305	0.6	RIGHT SIDE PYELONEPRITIS	IIIA	RIGHT EPN WITH PERINEPRIC COLLECTION WITH HUN	N/A	WARD	YES
6	1014874	VK	NORMAL	POSITIVE	E COLI	POSITIVE	E COLI	320	17	BULKY RIGHT KIDNEY WITH MILD PCS FULLNESS	IIIA	RIGHT EPN WITH PERINEPHRIC STRANDING	N/A	ICU	YES
7	1498553	BS	NORMAL	POSITIVE	E COLI	STERILE	NO GROWTH	90	0.2	RIGHT SIDE EPN WITH MILD HUN	I	RIGHT SIDE EPN WITH DISTAL URETERIC CALCULUS 11.9 MM	DTPA GFR RK:3 LK:28	WARD	YES
8	1512658	SK	PUS CELLS	POSITIVE	Pseudomonas luteola	STERILE	NO GROWTH	263	13	MILD TO MOD RIGHT HN	II	RIGHT RENAL PELVIC CALCULUS WITH EPN	N/A		YES
9	1420205	A	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	2	9	RIGHT SIDE EPN WITH MILD HUN	I	RIGHT SIDE EPN WITH HUN	N/A	WARD	YES
10	1195903	MB	PUS CELLS	POSITIVE	PROTEUS M	STERILE	NO GROWTH	369	68	LEFT EPN WITH MULTIPLE AIR FOCI	IIIA	LEFT EPN WITH LEFT PUJ CALCULUS OF SIZE 13*7 MM	N/A	WARD	YES
11	1508670	GS	RBC AND PUS CELL	STERILE	NO GROWTH	STERILE	NO GROWTH	86	0.62	LEFT PYELONEPRITIS	IIIB	LEFT EPN WITH UPPER URETERIC CALCULUS	N/A	ICU	YES
12	1535989	RG	PUS CELLS	POSITIVE	E COLI	POSITIVE	E COLI	362	100	RIGHT SIDE EPN WITH MILD HUN	I	RIGHT SIDE EPN WITH MILD HUN	N/A	YES	YES
13	1525205	SB	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	350	50	RIGHT SIDE PYELONEPRITIS	I	RIGHT SIDE EPN WITH MILD PCS FULLNESS	N/A	ICU	YES
14	1462681	AK	PUS CELLS	POSITIVE	Pseudomonas AERUGINOSA	STERILE	NO GROWTH	360	100	LEFT HUN WITH AIR FOCI	IIIB	LEFT EPN WITH PERINEPHRIC AND RETROPERITONEAL COLLECTION	N/A	ICU	YES
15	1466895	VK	PUS CELLS	STERILE	NO GROWTH	POSITIVE	E COLI	150	4.2	LEFT HUN WITH URETERIC CALCULUS WITH AIR FOCI	II	LEFT EPN WITH MID URETHERIC CALCULUS	N/A	WARD	YES
16	1597048	BK	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	360	100	BULKY LEFY KIDNEY WITH HUN AND PERINEPHRIC STRANDING	IIIA	LEFT BULKY KIDNEY WITH EPN AND PERINEPHRIC STRANDING	N/A	ICU	YES
17	1572296	KK	PUS CELLS		NO GROWTH	STERILE	NO GROWTH	340	12	BULKY LEFY KIDNEY	IIIA	LEFT BULKY KIDNEY WITH EPN AND PERINEPHRIC STRANDING	N/A	WARD	YES
18	1547311	HK	PUS CELLS	POSITIVE	Pseudomonas AERUGINOSA	POSITIVE	E COLI	360	100	RIGHT EPN WITH PERINEPHRIC COLLECTION	IIIB	RIGHT EPN WITH PERINEPHRIC COLLECTION WITH PYONEPHROSIS	N/A	ICU	YES

SR NO	MRD	INITIALS	MANAGEMENT						OUTCOME				FOLLOW UP 2 MONTHS	
			OXYGEN SUPPORT	IONOTROPIC SUPPORT	DIALYSIS	PCN/PCD	DJ STENTING	SURGICAL (NEPHRECTOMY)	IMPROVED AND DISCHARGED	DETERIORIATED	REINTERVENTION	DEATH	NCCT KUB/USG	OTHER
1	1377530	MR	YES	NO	NO	PCD	NO	NO	DISCHARGED WITH PCD	NO	NO	NO	RESOLVED	N/A
2	1400002	MK	NO	NO	NO	PCN	NO	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
3	1487831	NB	NO	NO	NO	PCN AND PCD	NO	YES	DISCHARGED	NO	NEPHRECTOMY	NO	RESOLVED	BIOPSY : CHRONIC PYELONEPRIOTIS WITH EPN
4	1362271	AK	YES	YES	NO	PCN	YES	NO	DISCHARGED WITH PCN	YES	PCN AND PCD	NO	RESOLVED	N/A
5	1336989	Y	NO	NO	YES	NO	YES	NO	DISCHARGED WITH PCN	YES	PCN AND PCD	NO	RESOLVED	N/A
6	1014874	VK	YES	NO	NO	NO	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
7	1498553	BS	NO	NO	NO	PCN AND PCD	YES	YES	DISCHARGED WITH DJ STENT	YES	NEPHRECTOMY	NO	RESOLVED	BIOPSY CAME AS TB , STARTED ON AKT
8	1512658	SK	NO	NO	NO	PCN	NO	NO	DISCHARGED WITH PCN	NO	NO	NO	RESOLVED	N/A
9	1420205	A	NO	NO	NO	PCN	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
10	1195903	MB	NO	NO	NO	YES	NO	LEFT PCNL	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
11	1508670	GS	NO	NO	NO	NO	YES	LEFT URSL	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
12	1535989	RG	NO	NO	NO	NO	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
13	1525205	SB	YES	YES	NO	NO	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
14	1462681	AK	YES	YES	NO	PCD AND PCN	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
15	1466895	VK	NO	NO	NO	NO	YES	LEFT URSL	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
16	1597048	BK	YES	YES	YES	PCN	NO	NO	DISCHARGED WITH PCN	NO	NO	NO	RESOLVED	N/A
17	1572296	KK	NO	NO	NO	PCN	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
18	1547311	HK	YES	YES	YES	PCD AND PCN	NO	YES	NO	YES	NEPHRECTOMY	YES	DEATH	DEATH

SR NO	MRD	INITIALS	AGE	GENDER	PRESENTING COMPLAINTS					DURATION OF SYMPTOMS		CO-MORBIDITIES				
					FEVER	FLANK PAIN	NAUSEA/ VOMITING	URINARY SYMPTOMS	ANY OTHER SYMPTOMS	<7 DAYS	>7 DAYS	DM	HTN	THYROID DISEASES	CAD	CKD
19	1550656	JS	59	M	YES	NO	YES	YES	WEAKNESS, ANOREXIA	YES	NO	YES	YES	YES	NO	MO
20	1599280	AK	52	F	YES	YES	YES	NO	NO	YES	NO	YES	NO	NO	NO	NO
21	1583955	GS	39	M	YES	YES	YES	YES	WEAKNESS, ANOREXIA	YES	NO	YES	NO	NO	YES	NO
22	1547311	HK	53	F	YES	YES	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO
23	1574973	DR	63	M	YES	NO	YES	NO	WEIGHT LOSS	NO	YES	YES	YES	NO	NO	NO
24	1613617	NK	58	M	YES	NO	NO	YES	NO	NO	YES	YES	NO	NO	NO	NO
25	1687900	RK	58	M	NO	NO	NO	YES	NO	YES	NO	NO	YES	NO	NO	NO
26	1628852	PL	50	F	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
27	1627306	RB	56	F	YES	NO	NO	NO	NO	YES	NO	YES	YES	YES	YES	NO
28	1706313	KK	41	F	YES	NO	YES	YES	NO	NO	YES	YES	NO	NO	NO	NO
29	1529875	K	55	F	YES	NO	NO	YES	NO	YES	NO	YES	YES	NO	YES	YES
30	1696451	HS	45	M	YES	YES	YES	NO	NO	NO	YES	NO	YES	NO	NO	YES
31	1741411	ZB	62	F	YES	YES	YES	YES	WEAKNESS,ANOREXIA	YES	NO	YES	YES	NO	NO	NO
32	1476105	CS	55	M	YES	NO	NO	NO	NO	YES	NO	YES	YES	NO	NO	NO
33	1708039	SS	68	M	YES	YES	NO	NO	NO	YES	NO	YES	YES	NO	NO	NO
34	1332271	VGS	65	F	YES	NO	NO	YES	K/C/O CA BREAST POST MRM POST CHEMOTHERAPY, MORBIDLY OBESE	NO	YES	YES	YES	YES	NO	NO
35	172756	SR	56	F	YES	YES	NO	YES	NO	NO	YES	YES	YES	YES	NO	NO

SR NO	MRD	INITIALS	VITALS					HEMOGRAM			RENAL FUNCTION TEST			HBA1C
			LEVEL OF CONCIOUSNESS	TACHYCARDIA >100/MIN YES/NO	HYPOTENSION <100/60MMHG YES/NO	SPO2 (OXYGEN REQUIREMENT) YES/NO	NEED OF IONOTROPICS	ANEMIA	LEUCOCYTOSIS	THROMBOCYTOPENIA	SR CREATININE	BLOOD UREA	ELECTROLYTES	
19	1550656	JS	CONCIOUS	YES	NO	NO	NO	NO	YES	NO	DERRANGED	NORMAL	DERRANGED	8
20	1599280	AK	CONCIOUS	YES	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	DERRANGED	9
21	1583955	GS	DROWSY	YES	YES	YES	YES	YES	YES	YES	DERRANGED	DERRANGED	DERRANGED	16
22	1547311	HK	DROWSY	YES	YES	YES	YES	YES	YES	NO	DERRANGED	DERRANGED	DERRANGED	8
23	1574973	DR	CONCIOUS	YES	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	7.9
24	1613617	NK	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	12
25	1687900	RK	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	5.3
26	1628852	PL	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	7.9
27	1627306	RB	DROWSY	YES	YES	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	NORMAL	8.9
28	1706313	KK	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	12
29	1529875	K	CONCIOUS	NO	NO	NO	NO	YES	YES	NO	DERRANGED	DERRANGED	NORMAL	10
30	1696451	HS	CONCIOUS	YES	YES	YES	YES	YES	YES	NO	DERRANGED	DERRANGED	NORMAL	5.6
31	1741411	ZB	CONCIOUS	YES	NO	NO	NO	NO	YES	NO	DERRANGED	NORMAL	NORMAL	12
32	1476105	CS	CONCIOUS	NO	NO	NO	NO	NO	NO	NO	NORMAL	NORMAL	NORMAL	6.6
33	1708039	SS	CONCIOUS	NO	NO	NO	NO	NO	NO	NO	NORMAL	NORMAL	NORMAL	6.6
34	1332271	VGS	CONCIOUS	YES	NO	YES	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	8.6
35	172756	SR	CONCIOUS	NO	NO	NO	NO	NO	YES	NO	NORMAL	NORMAL	NORMAL	7.5

SR NO	MRD	INITIALS	INVESTIGATIONS												
			URINE R/E	URINE CULTURE		BLOOD CULTURE		CRP-Q	PCT	IMAGING					
				NO GROWTH	ORGANISM ISOLATED	NO GROWTH	ORGANISM ISOLATED			USG	CT GRADING OF EPN	NCCT KUB ON PRESENTATION	OTHER	WARD /ICU	ANTIBIOTICS
19	1550656	JS	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	250	15	BULKY LEFY KIDNEY WITH HUN AND PERINEPHRIC STRANDING	IIIA	LEFT BULKY KIDNEY WITH EPN AND PERINEPHRIC STRANDING	N/A	WARD	YES
20	1599280	AK	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	125	0.05	EVOVING LEFT RENAL ABSCESS	IIIB	LEFT BULKY KIDNEY WITH MULTILOCULATED CYST WITH AIR FOCI AND ABSCESS	N/A	WARD	YES
21	1583955	GS	PUS CELLS	POSITIVE	E COLI	POSITIVE	E COLI	340	100	RIGHT EPN	IIIB	RIGHT EPN WITH PYONEPHROSIS	N/A	ICU	YES
22	1547311	HK	RBC AND PUS CELL	POSITIVE	KLEBSIELLA	STERILE	NO GROWTH	350	100	LEFT EPN WITH COLLECTION	II	LEFT PYONEPHROTIC KIDNEY WITH EPN	N/A	ICU	YES
23	1574973	DR	PUS CELLS	POSITIVE	E COLI	POSITIVE	E COLI	360	23	LEFT EPN WITH PERINEPRIC STRANDING	II	LEFT EPN	N/A	WARD	YES
24	1613617	NK	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	315	50	LEFT EPN	II	LEFT EPN	N/A	WARD	YES
25	1687900	RK	PUS CELLS	STERILE	NO GROWTH	STERILE	NO GROWTH	120	0.3	RIGHT EPN	II	RIGHT EPN	N/A	WARD	YES
26	1628852	PL	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	165	10	RIGHT PYELONEPRITIS WITH MINIMAL HUN	I	RIGHT EPN	N/A	ICU	YES
27	1627306	RB	PUS CELLS	STERILE	NO GROWTH	STERILE	NO GROWTH	111	0.09	LEFT PN WITH HUN	I	LEFT EPN WITH URETHERIC CALCULUS	N/A	WARD	YES
28	1706313	KK	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	315	50	LEFT EPN	I	LEFT EPN	N/A	WARD	YES
29	1529875	K	PUS CELLS	POSITIVE	KLEBSIELLA	STERILE	NO GROWTH	303	50	RIGHT EPN WITH PERINEPHRIC COLLECTION	IIIA	RIGHT EPN WITH PERINEPRIC COLLECTION WITH HUN	N/A	WARD	YES
30	1696451	HS	PUS CELLS	STERILE	NO GROWTH	STERILE	NO GROWTH	115	0.06	BILATERAL ADPKD WITH LEFT EPN	IV	BILATERAL ADPKD WIT LEFT EPN	N/A	ICU	YES
31	1741411	ZB	FUNGUS	POSITIVE	ENTEROCOCCUS FAECIUM	POSITIVE	ENTEROCOCCUS FAECIUM	315	9	LEFT UPPER URETERIC CALCULUS WIT PYONEPHROSIS AND AIR FOCI	II	LEFT EPN WITH UPPER URETERIC CALCULUS	N/A	WARD	YES
32	1476105	CS	RBC AND PUS CELL	POSITIVE	KLEBSIELLA	STERILE	NO GROWTH	86	0.62	LEFT PYELONEPRITIS WITH HUN ? CALCULUS	II	LEFT EPN WITH UPPER URETERIC CALCULUS	N/A	WARD	YES
33	1708039	SS	RBC AND PUS CELL	POSITIVE	KLEBSIELLA	STERILE	NO GROWTH	86	0.62	LEFT PYELONEPRITIS WITH HUN ? CALCULUS	II	LEFT EPN WITH UPPER URETERIC CALCULUS	N/A	WARD	YES
34	1332271	VGS	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	150	6	COLLECTION IN RIGHT RENAL FOSSA EXTENSION TO PSOAS MUSCLE	IIIB	RIGHT EMPYSEMATOUS PYELONEPHRITIS WITH PERINEPHRIC COLLECTION 14*17 CM WITH PYONEPHROSIS	N/A	WARD	YES
35	172756	SR	PUS CELLS	POSITIVE	E COLI	STERILE	NO GROWTH	46	0.26	LEFT PYELONEPHRITIS	I	LEFT EPN	N/A	WARD	YES

SR NO	MRD	INITIALS	MANAGEMENT						OUTCOME				FOLLOW UP 2 MONTHS	
			OXYGEN SUPPORT	IONOTROPIC SUPPORT	DIALYSIS	PCN/PCD	DJ STENTING	SURGICAL (NEPHRECTOMY)	IMPROVED AND DISCHARGED	DETERIORIATED	REINTERVENTION	DEATH	NCCT KUB/USG	OTHER
19	1550656	JS	NO	NO	NO	PCN	NO	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
20	1599280	AK	NO	NO	NO	PCN AND PCD	NO	YES	DISCHARGED	NO	NEPHRECTOMY	NO	RESOLVED	BIOPSY : EPN
21	1583955	GS	YES	YES	YES	PCN	YES	NO	NO	YES	NO	YES	DEATH	DEATH
22	1547311	HK	YES	YES	NO	PCD	NO	YES	DISCHARGED	NO	NEPHRECTOMY	NO	RESOLVED	BIOPSY : EPN
23	1574973	DR	NO	NO	NO	PCN	NO	YES	DISCHARGED	YES	NEPHRECTOMY	NO	RESOLVED	BIOPSY : CHRONIC PYELONEPRIOTIS WITH EPN
24	1613617	NK	NO	NO	NO	PCN	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
25	1687900	RK	NO	NO	NO	NO	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
26	1628852	PL	NO	NO	NO	NO	NO	NO	DISCHARGED	NO	NO	NO	RESOLVED	N/A
27	1627306	RB	NO	NO	NO	NO	YES	LEFT URSL	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
28	1706313	KK	NO	NO	NO	PCN	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
29	1529875	K	NO	NO	NO	PCN AND PCD	YES	NO	DISCHARGED WITH DJ STENT	NO	NO	NO	RESOLVED	N/A
30	1696451	HS	YES	YES	YES	NO	NO	YES	DISCHARGED	YES	EXPLORATORY LAPAROTOMY WIT DECOMPRESSION OF BOWEL	NO	RESOLVED	N/A
31	1741411	ZB	NO	NO	NO	PCN	NO	NO	DISCHARGED WITH PCN	NO	NO	NO	ON FOLLOW UP	N/A
32	1476105	CS	NO	NO	NO	NO	YES	LEFT URSL	DISCHARGED	NO	NO	NO	RESOLVED	N/A
33	1708039	SS	NO	NO	NO	NO	YES	LEFT URSL	DISCHARGED	NO	NO	NO	RESOLVED	N/A
34	1332271	VGS	YES	NO	NO	PCD	NO	NO	NO	NO	NO	NO	DEATH	N/A
35	172756	SR	NO	NO	NO	PCD	NO	NO	DISCHARGED	NO	NO	NO	RESOLVED	N/A

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The Principal
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Ludhiana

Subject:: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 25.09.2023 has approved the plan of thesis of **Narwade Pankaj Chandrakant**, a student of your college for **MCh Urology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
A study of clinical profile and outcome in patients with emphysematous pyelonephritis undergoing minimally invasive treatment. .

Supervisor
Dr. Sandeep Sharma
Prof. & Head
Dept. of Urology

Co-Supervisor:-
Dr. Harmandeep Singh Chahal
Assoc. Professor
Dept. of Urology

The student may submit the thesis in triplicate alongwith the plan in triplicate also, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*

A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED
IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MCh

IN

UROLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES
FARIDKOT

OCTOBER, 2022

DR. NARWADE PANKAJ CHANDRAKANT

DEPARTMENT OF UROLOGY
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT
For the degree of	MCh Urology
Name of the candidate	Dr. Narwade Pankaj Chandrakant
Supervisor	Dr. Sandeep Sharma
Co-supervisor	Dr. Harmandeep Singh Chahal
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: The term emphysematous pyelonephritis (EPN) was first used by Schultz and Klorfein and is applied when gas is formation in or around the kidney. EPN presents a urologic emergency.The situation of standard treatment of nephrectomy of affected kidney for emphysematous pyelonephritis has improved in the last two decades with computed tomography (CT) scan based diagnosis and advances in multi-disciplinary intensive care of sepsis syndrome aiming at renal conservation by minimal invasive approaches.

Aim of Study: 1.To study clinical profile of patients presenting with emphysematous pyelonephritis. 2 To evaluate minimal invasive treatment options and outcome in management of emphysematous pyelonephritis.

Materials & Methods: The study will be conducted among the patients admitted to Department of Urology, Dayanand Medical College and Hospital, Ludhiana from 1st sept 2022. The study design is a prospective observational study. Information shall be collected through a pre- designed proforma for each patient chosen to be a part of the study with detailed history, clinical examination and complete investigational workup and management. Details of the study will be explained to each case. Analysis will be done with the collected details. A pre-informed consent from each patient shall be taken.

Clinical Significance: EPN is a common disorder affecting diabetic population. The clinical scenario of EPN has changed over the years. Owing to widespread availability of better investigating tools, early detection has become possible. With more effective newer antibiotics and better intensive care including dialysis support services, and better drainage modalities the outcome in these patients has improved remarkably.

Keywords: EPN, Diabetes, nephrectomy.

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT"** exist in the Department of Urology, DMC&H, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis is genuine and is collected by the candidate himself/herself under our supervision and guidance.

Supervisor

Dr. Sandeep Sharma
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Department of Urology
DMCH, Ludhiana.

Co-Supervisor

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Associate Professor
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Head of the Department

Dr. Sandeep Sharma
Professor & Head
Department of Urology
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Place : _____

Date : _____

APPROVAL PROFORMA
BYRESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Narwade Pankaj Chandrakant
Department	MCh Urology
Topic of Thesis	A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT
Likely date of appearing in PG examination	May/June, 2024
Date of enrollment	30.04.2020
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BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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3	COURSE OF STUDY AND SUBJECT	M.Ch UROLOGY
4	DATE OF ADMISSION OF COURSE	30th APRIL 2022.
5	TITLE OF THE TOPIC	A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Emphysematous pyelonephritis (EPN) is a potentially life-threatening necrotising infection affecting the renal unit with the characteristic presence of gas having reported mortality of 19% to 43%.[1-2] EPN is common in immune-compromised diabetic females with obstructed urinary system with classical triad of fever, vomiting and flank pain.[3]
Emphysematous pyelonephritis (EPN), first defined by Kelly and MacCallum in 1898, is a rare but life-threatening, acute suppurative infection of the kidney. It is characterized by gas production within the renal parenchyma, collecting system, or perinephric tissue. Mortality is due to septic complications arising from the disease process.[3]

EPN is an uncommon condition where many studies have reported a wide range of clinical profiles and causative organisms. There are no specific symptoms or signs to diagnose EPN. E. Coli and Klebsiella spp. are the most common causative organisms, but the exact pathogenesis is poorly understood.[4]

Presently, non-contrast computed tomography of kidney, ureter, and bladder (NCCT-KUB) is the imaging modality of choice.[5]
Traditionally Until the mid-1980s, nephrectomy was the standard treatment as the non-surgical treatment led to mortality of 60–80% early nephrectomy has been considered the treatment of choice for EPN.[6-7] The treatment options in EPN have evolved over the years from an aggressive surgical approach to a more conservative approach. Recently, minimally invasive interventions have gained popularity due to better imaging and advances in image-guided procedures.[8-9]

Management of EPN may range from conservative approaches like vigorous resuscitation, antibiotic treatment and glycaemic control to adequate urinary drainage (Double J stenting/Percutaneous nephrostomy/Percutaneous Drainage) and nephrectomy in refractory cases. There are a few articles that compared the emergency nephrectomy, Percutaneous Drainage (PCD) and medical

management and there are few studies in which medical management alone was associated with a significantly lower mortality rate.[10]

There are quite a few case series and studies from India that emphasizes on clinical spectrum, pathogenesis, management and outcome of EPN and most of them are retrospective in nature.[11]

The aim of this study is to assess the clinical profile, risk factors and mode of presentation, organisms and antibiotic sensitivity pattern, role of minimally invasive treatments, associated morbidity and mortality and efficacy and outcome of minimally invasive treatments in adult presenting with diagnosed case of EPN requiring hospitalization and was to check likelihood of kidney salvagibility by minimally invasive treatment options in EPN without need of nephrectomy.

6.2 REVIEW OF LITERATURE

Definition:

Emphysematous pyelonephritis (EPN), first defined by Kelly and MacCallum in 1898, is a rare but life-threatening, acute suppurative infection of the kidney. It is characterized by gas production within the renal parenchyma, collecting system, or perinephric tissue.[12]

Sites:

Gas-forming infections can develop anywhere in the upper or lower urinary tracts, as follows:

1. in the renal parenchyma (emphysematous nephritis)
2. Calyx and pelvis (emphysematous pyelitis)
3. Ureter (emphysematous ureteritis)
4. Urinary bladder (emphysematous cystitis)

Etiology:

Emphysematous pyelonephritis occurs almost exclusively in patients with diabetes mellitus (DM), but occasionally in patients without DM along with obstruction of the corresponding Reno ureteral unit.

Causative organisms:

The main causative organisms in EPN are those normally found in urinary and gastrointestinal tracts. In the study by Michaeli et al Escherichia coli was the most common organism (71%). In 19% of the cases >1 organism was present. Aerobacter aerogenes and Proteus mirabilis were isolated in some patients. In the study by Huang et al, pathogens was identified in 98% of cases. E.coli was the commonest organism isolated (69%), K.pneumoniae was the second (29%).[12]

Role of diabetes mellitus:

EPN most commonly occurs in diabetics. Diabetic patients are compromised hosts and they have an impaired defense mechanism for bacterial infection.[13] In Michaeli et al's study, diabetes mellitus occurred in 87 of the patients. Though it has long been postulated that EPN is found exclusively in uncontrolled diabetics, it has also been reported in non-diabetics and diabetics with excellent diabetes control.

In the non-diabetic patients, EPN is almost always associated with ureteral obstruction.[14]

The role of obstruction:

Obstruction was present only in 40% of patients of Michaeli et al.[14] He refutes the notion that obstruction of the 13 urinary tract is necessary for gas formation. However, most of the patients with bilateral EPN and EPN in solitary kidneys had urinary tract obstruction. In the non-diabetic patient, EPN nearly always is associated with ureteral obstruction.[14]

CLASSIFICATION

Wan et al:

Type I

Renal necrosis with either total absence of fluid content on CT or the presence of a streaky/mottled gas pattern demonstrated on radiograph or CT with lung window display.

Type II

Characterized either by the presence of renal/perirenal fluid in association with a bubbly/lo culated gas pattern or by the presence of gas in the collecting system.

Type I emphysematous pyelonephritis is associated with more extensive parenchymal necrosis and a more fulminating clinical course than type II.[15]

Huang et al Classification:

Class 1 – Gas in the collecting system only (Emphysematous pyelitis).

Class 2 – Gas in the renal parenchyma without extension into the extrarenal space

Class 3A- Extension of gas or abscess to the perinephric space

Class 3B- Extension of gas or abscess to the pararenal space

Class 4 – Bilateral EPN/Solitary kidney with EPN[16]

CLINICAL PRESENTATION

EPN presents mostly in adults.[13] Women are affected more often than men.[14] The usual clinical presentation is severe, acute pyelonephritis that fails to resolve during the first 3 days of treatment. In some 24 cases, a chronic infection precedes an acute attack. Almost all patients display the classic triad of fever, vomiting and flank pain. Pneumaturia is absent unless the infection involves the collecting system. In study conducted by Amit Kumar Sharma et al.[17] The clinical features of EPN in patients were pain in flank (70%) and fever (80%) being the predominant symptom which was similar to the study conducted by Ahmed R et al.[15] Results of urine cultures are invariably positive. Most frequently identified organism is E.coli; Klebsiella and Proteus are less common. The average duration of symptoms before diagnosis was 21 days- the range being 0.5 to 240 days. Huang et al reported fever in 79%, nausea/vomiting in 17% shock in 29%, altered consciousness in 19% and acute renal functional impairment in 35% of patients.[16] Leukocytosis is seen in about 67% and thrombocytopenia in 46%.[16] Patients may present in a state of medical emergency viz., diabetic ketoacidosis.

MANAGEMENT

Patients with EPN are acutely ill and supportive measures should be rapid. Vigorous measures aimed at glycaemic control, maintenance of fluid balance and treatment of shock should be initiated as quickly as possible. Empirical broad spectrum antibiotics should be started when the diagnosis is suspected and the antibiotics can be tailored according to sensitivity once culture results are available. Obstruction, if present, should be relieved urgently.

According to Schultz and Klorfein, the disease is best treated by conventional medical methods and is not an indication of emergency surgery. They concluded that contralateral disease was often present and nephrectomy was unwarranted.[18]

Joseph.B.Stokes JR[19], Dunn and Dewolf et al, in their study of 3 cases treated by nephrectomy[20] favoured an initial trial of conservative

management with antibiotics. Their main concern was the possibility of recurrent disease in the contralateral kidney.

Nephrectomy could be considered if the renal and perirenal gas or the toxic symptoms persist. They suggested that such patients be started on lifelong suppressive antibiotics and be followed up strictly. They concluded that medical management of EPN was preferable due to the high chances of the opposite kidney being involved, especially in diabetics. Avoidance of surgery, vigorous blood sugar control, appropriate antibiotics and relief of obstruction was rational.

Traditionally the consensus was that mere medical treatment was ineffective and prompt surgical drainage was[17] recommended and nephrectomy was often necessary. Mortality rate in patients who are treated only with antibiotics is 40%.

Treatment is successful in 66% of patients who are treated with percutaneous nephrostomy and antibiotics, and in 90% of those with nephrectomy.[21] Renal conservation has come into vogue for reasons already mentioned. The need to save the kidney in the setting of a high probability of the disease occurring in the opposite side later as well as the long term effects of diabetes on the opposite kidney. Patients presenting with synchronous bilateral disease as well as EPN affecting a solitary kidney present unenviable situations where renal conservation is highly desirable. Huang et al[1] emphasized the importance of perinephric extension of gas. Even though the differences in clinical features among the 4 classes was not significant, there was a tendency towards higher mortality and failure of PCD from class 1 to 4. The best prognosis was enjoyed by class 1 patients. All of them survived with PCD and antibiotics with relief of obstruction whenever necessary. In class 2 also, all patients treated so, were [17] cured. For patients with extension of gas beyond renal parenchyma or bilateral EPN (class 3 and 4), 85% of patients with <2 risk factors (thrombocytopenia, acute renal functional impairment, disturbed consciousness and shock) successfully responded to PCD and antibiotics. The failure rate of conservative treatment (i.e. combined medical and minimally invasive treatment) was 15% for those with no

or a single risk factor and 92% for those with 2 or more risk factors. In such cases, nephrectomy is expected to give the best management outcome. The advantages of PCD are that it drains the pus, releases the gas and hence the pressure to local circulation, provides pus that can be cultured and can help in further management and can provide increased rates of success in extensive EPN. They suggest PCD and antibiotics less extensive disease (class 1 & 2) and for extensive EPN with < 2 risk factors.

This leads to a renal conservation in most of the cases. Nephrectomy provided the best treatment outcome for extensive EPN with fulminant course (2 or more risk factors). In managing class 4 EPN, bilateral PCD should be tried first. Emergency[22] nephrectomy carries a high risk in these patients. Nephrectomy should be done if PCD fails. Poor glycemic control was not a poor prognostic factor. Patients seen initially with organ systems dysfunction ran a rapid course with poor outcome. Severe proteinuria correlated with poor outcome and seemed to be a risk factor for extensive disease. The causes of severe proteinuria may be multifactorial with fever, underlying glomerulonephritis, and diabetic nephropathy may contribute.

Bum Soo Park et al[23] consider nephrectomy to be the most effective modality of treating EPN. They were for immediate nephrectomy and all supportive and resuscitative measures were to be carried concomitantly. Their indications for renal conservation (with PCD and antibiotics) were solitary kidney, poor general/medical condition rendering the patient unfit for surgery, inadequate contralateral kidney and bilateral disease. For nephrectomy, they preferred a 11th rib bed approach through the loin.

Hung et al[1] have noted anaerobic bacteria, B. fragilis as the causative organism in a case of EPN. Anaerobic bacteria had never been found to be a causative pathogen except in one case with Clostridium.[24] They consider ascent and invasion of anaerobes indigenous to the lower urethra, or a spread from adjacent organs such as the bowel or uterus as the probable source. The presence of obstruction may reduce the oxygen tension and impair tissue immunity and might

predispose to EPN.[14] Hence they recommend that empirical treatment should also cover anaerobes in obstruction-related EPN.

In study conducted by Amit Kumar Sharma et al.[17], all good outcome patients were managed conservatively with the use of antibiotics, PCN, Percutaneous Catheter Drainage (PCD) with DJ stenting while, nephrectomy was done in total 9 (30%) cases in poor outcome group. There was no mortality seen in the study. Study by Huang JJ and Tseng CC and Sokhal AK et al., was associated with mortality in 18.8% patient and 8% patients, respectively.[25-26]

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To study clinical profile of patients presenting with emphysematous pyelonephritis.
- To evaluate minimal invasive treatment options and outcome in management of emphysematous pyelonephritis.

7.0 MATERIALS AND METHODS

STUDY DESIGN - The study design is a prospective observational study.

SAMPLE SIZE – Time bound study

SOURCE OF DATA:

The study will be conducted among the patients admitted to department of Urology, Dayanand Medical College and Hospital, Ludhiana from 1st sept 2022 to 1st Aug 2024.

Information shall be collected through a pre- designed performa for each patient chosen to be a part of the study with detailed history, clinical examination and complete investigational workup. Details of the study explained to each case. Analysis will be done with the collected details prospectively. A pre-informed consent from each patient shall be taken.

METHOD OF COLLECTION OF DATA :

Case admitted in DMCH of Age ≥ 18 and either gender with unilateral or bilateral EPN consenting to participate in the study and not having any above mentioned exclusion criteria will be included in the study.

All the patients who presented with fever, loin pain and vomiting underwent preliminary Xray KUB and USG abdomen. If findings suspicious of gas were present, they underwent NCCT KUB (or with contrast enhancement if indicated). Patients in whom gas could not be identified in either of these modalities underwent CT KUB based on clinical suspicion due to toxic clinical features. The patients were stratified based on Huang et al's CT classification [8] On admission, baseline characteristics recorded included age, gender, history, duration of and treatment for diabetes mellitus, and duration of symptoms. The clinical features recorded included hemodynamic status, the degree of consciousness, hydration status. Blood glucose level, serum creatinine, blood urea, total and differential WBC counts,

blood haemoglobin level and urine ketone were recorded on admission. A blood platelet count was done.

Shock was defined as systolic BP <90 mm Hg. Raised renal parameter was defined as serum creatinine > 1.5 mg% or blood urea >40mg%. Altered consciousness was defined as patient in confusion, delirium, stupor or coma.

All patients were started on 3rd generation cephalosporins (cefotaxime, ceftriaxone or cefoperazone) and metrogyl. Aminoglycosides were added if renal parameters were normal. Antibiotics were later changed if necessary, based on culture and sensitivity. Vigorous resuscitation was carried out with hydration, correction of electrolyte imbalance if any and diabetes control measures was initiated with insulin in all the cases.

All patients were stratified to initially undergo conservative management with only antibiotics, antibiotics with PCD &/or DJ stenting. PCD was defined as percutaneous aspiration of pus and gas with/without percutaneous nephrostomy.

PCN was done under USG guidance using 8.5Fr single puncture nephrostomy catheter in prone, prone oblique or lateral positions via the flank taking care to avoid contamination of the peritoneum.

Unsuccessful PCD was defined as progressive or persistent lesions on radiological studies with a clinical picture of unstable hemodynamic status or prolonged fever after management. Our patients, depending on outcome, were stratified into the “good” and “poor” outcome groups. The “good” outcome group included patients treated with antibiotics only or PCD +/- DJ stenting or DJ stenting only with antibiotics. The “poor” outcome group included patients who had unsuccessful PCD followed by nephrectomy or mortality. Patients will be followed at 3 month interval to check for response to treatment.

INCLUSION CRITERIA

1. Age ≥ 18 of either gender.
2. Patients admitted based on clinical features and documentation of gas within the renal system on CT scan.

EXCLUSION CRITERIA

1. Patients with features of acute pyelonephritis without gas in the renal parenchyma.
2. History of recent endoscopic or open interventions or recent catheterization of the in the urinary tract.
3. Any fistula between the bowel and urinary tract.
4. Recent urinary trauma.

DURATION OF STUDY – November, 2022 to January, 2024.

OUTCOME- The outcome of the study will be defined as there is definite role of renal conservation by minimally invasive treatment like PCD +/- DJ stenting over traditional upfront nephrectomy. Morbidity of minimally invasive treatment is limited and response to treatment is similar to surgery (nephrectomy).

STATISTICAL ANALYSIS

Data will be described in terms of range, mean +/- , standard deviation, frequencies (number of cases) and relative frequencies (percentages**)**

For discrete data -proportion is computed and the mean and standard deviation will be computed for the continuous data. The chi square test will be applied to compare the proportions between the groups to assess the statistical significance. All analyses will be two tailed and p <0.05 will be considered significant. SPSS version 21.0 will be used for data analysis.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

Routine blood and urine test, x ray KUB, Renal Ultrasound, NCCT – KUB.

7.4 HAS ETHICAL CLEARENCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith.

8. LIST OF REFERENCES

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16. Huang, J.J. and Tseng, C.C., 2000. Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. Archives of internal medicine, 160, pp.797-5.
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PROFORMA

Sr. No. ___

Patient sticker:

Complaints:_____
_____
_____
_____

Duration of symptoms:

H/O DM (along with duration and treatment)

Clinical examination
Vitals:
Temp:
HR:_____/min
BP:_____/_____mmhg
SPO2: _____%

Level of consciousness:

Loin Tenderness :

Investigations at presentation

Blood sugar

Serum creatinine_____mg/dl

Blood urea_____mg/dl

Total WBC count: _____

Haemoglobin: _____

Platelet count: _____

Signature of Candidate Signature of Supervisor

Urine acetone: _____

Urine culture & sensitivity: _____

Blood culture: _____

Mode of diagnosis

NCCT KUB: _____

Presence of obstruction

USG KUB: _____

Treatment category
Antibiotics used

Post conservative management serum creatinine

Post conservative management platelet count

Post conservative management recovery of signs and symptoms

Post conservative management CT

Follow up treatment if any

Outcome

Number of days of hospital stay

Signature of Candidate Signature of Supervisor

INFORMED PATIENT CONSENT

Date: _____

I……..D/o, W/o, S/o……
……am willing to participate in the study **"A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

……. ……
Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक केहस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____ **"A STUDY OF CLINICAL PROFILE AND OUTCOME IN PATIENTS WITH EMPHYSEMATOUS PYELONEPHRITIS UNDERGOING MINIMALLY INVASIVE TREATMENT"** ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ